RIHIGPGRAFYTTKNIIGTI

QUERY	RIHIGPGRAFYTTKNIIGTI
CONSENSUS_A	i??GpGqafYa-gdi-.-d-
A.GB.MA246	I..GPGQAFYA-GEI-.-N-
A.GB.MC108	I..GPGQAFYA-NDI-.-N-
A.KE.K89	I..GPGQAFYA-GDI-.-N-
A.KE.Q23-CXC-CG	I..GPGQAFYA-GDI-.-D-
A.NG.NG1935	I..GPGQTFYA-GEI-.-D-
A.RW.KIG93	I..GPGQAWYARGNM-.-D-
A.RW.SF1703	I..GPGQAFYA-GDI-.-D-
A.SE.SE6594	I..GPGRSFYT.GDIK.-S-
A.SE.SE7253	I..GPGQAFYA-GDIT.-D-
A.SE.SE7535	I..GPGKVFYA-GEI-.-D-
A.SE.SE8131	I..GPGQAFYGMGDI-.-D-
A.SE.SE8538	I..GPGQAFYA-GEV-.-D-
A.SE.SE8891	I..GPGQAFYA-GDI-.-D-
A.UG.92UG037	I..GPGQTFYA-GDI-.-D-
A.UG.U455	YSIGSGQAFYV-G-I-.-D-
A.UG.UG273A	I..GPGQAFYA-GDI-.-D-
A.UG.UG275A	I..GPGQSFYA-GDI-.-D-
CONSENSUS_B	i??gpgrafyt-gei-.-d-
B.AU.MBC18	I..GPGRAFYT-.EI-.-D-
B.AU.MBC200	I..GQRRAFYA-G-I-.-D-
B.AU.MBC925	I..GPGRAFYA-GDI-.-N-
B.AU.MBCC54	I..GPGKAFYA-xEI-.-D-
B.AU.MBCC98	I..GPGRAFYA-.DI-.-D-
B.AU.MBCD36	L..GPGKVFYT-G.IT.-D-
B.BE.SIMI84	GPKRAFYATGDIGGYT.-Y-
B.CN.RL42	L..GPGKAWYT-GQI-.-D-
B.DE.D31	I..GARRAFYTKG-I-.-D-
B.DE.HAN	I..GPGRAVYT-GRIV.-D-
B.ES.89SP061	GHVGPGRAIYT-G.I-.-K-
B.FR.HXB2	--QR------V-IGK-.-NM
B.FR.PHI120	M..GPGKAFYT-GEI-.-D-
B.FR.PHI133	I..GPGSAFYT-GQI-.-D-
B.FR.PHI146	I..GPGRAFYT-GDI-.-D-
B.FR.PHI153	I..APGRAFYT-GAI-.-D-
B.FR.PHI159	I..GPGSAFYT-GEI-.-D-
B.FR.PIH155	I..GPGQAFYA-GEI-.-D-
B.FR.PIH160	I..GPGRAFYA-GDI-.-N-
B.FR.PIH309	I..GPGRAFYA-GDI-.-D-
B.FR.PIH373	I..GPGRAFYA-GEI-.-D-
B.FR.PIH374	I..GPGRAFYA-GQI-.-D-
B.GA.OYI	I..GPGRAFHT-KQI-.-D-
B.GB.AC-46	L..GPGSAWYA-GGI-.-D-
B.GB.CAM1	I..GPGRTVYA-DRI-.-D-
B.GB.GB8.C1	M..GPGR-FYT-GRI-.-D-
B.GB.JB	M..GPGRAFYT-GQI-.-D-
B.GB.M23470	I..GPGRAFYA-GD--.-D-
B.GB.M26864	I..GPGRAFLT..EIV.-D-
B.GB.M30156	M..GPGRVYYT-GEI-.-D-
B.GB.M737677	I..GPGEAL-T-.DI-.-N-
B.GB.M737685	I..GPGRAWYA-GEI-.-D-
B.GB.MANC	I..GPGR-FHV-RAVT.-D-
B.GB.MB314	I..GPGRAFYA-GDI-.-D-
B.GB.WB	I..GPGRAFHA-GRI-.-D-
B.JP.ETR	M..GPGRVYYT-GEI-.-D-
B.JP.JH32	I..GPGRAFYT-KQIA.-DL
B.NL.3202A21	I..GPGKAFYA-GQI-.-D-
B.NL.68A	I..GPGRAFYT-GQI-.-N-
B.NL.ENVVA	I..GPGRAVYT-GRI-.-D-
B.NL.ENVVF	I..GPGRAFYAAR-I-.-D-
B.NL.ENVVG	M..GPGKAFYA-GQI-.-D-
B.NL.H0320-2A12	I..GPGRAFYAAR-I-.-D-
B.TH.TH936705	L..GPGQAWYT-GQI-.-D-
B.TT.QZ4589	I..GPGRAFYT.GEI-.-D-
B.TW.LM49	I..GTGRVFYT.#QT-.-N-
B.US.85WCIPR54	I..GPGRAFYT-GEI-.-D-
B.US.92US657.1	I..GPGRAFYT-GEV-.-N-
B.US.ADA	I..GPGRAFYT-GEI-.-D-
B.US.ALA1	I..GPGRAFHT-RQI-.EN-
B.US.BC	T..GPGRVYYT-GEIV.-D-
B.US.BRVA	M..GPGRVYYT-GQI-.-D-
B.US.C26-12.1BH	I..GPGRAFYT-GEV-.-N-
B.US.CDC452	L..GPGRVWYT-GEIL.-N-
B.US.DH123	L..GPGRVFYT-GEIV.-D-
B.US.ENVUS-R2	M..GPGRAFYT-GQI-.-D-
B.US.JRCSF	I..GPGRAFYT-GEI-.-D-
B.US.JRFL	I..GPGRAFYT-GEI-.-D-
B.US.M02-3.SW	I..GPGRAFYA-GTI-.-D-
B.US.MNCG	I..GPGRAFYT-KNI-.---
B.US.NC7	HR..-Y--S-V-VRKL.-DR
B.US.NL43E9	--QR------V-IGK-.-NM
B.US.NY5CG	I..GPGRTLYARE-I-.-D-
B.US.P896	I..GPGRAFYARRNI-.-D-
B.US.RF	K..GPGRVIYA-GQI-.-D-
B.US.SC	I..GPGRAFYA-GDI-.-D-
B.US.SC141	I..GPGQALYA-EAI-.EN-
B.US.SC14C	I..GPGQALYA-GAI-.-D-
B.US.SF128A	I..GPGRAIYT-GAI-.-D-
B.US.SF2	I..GPGRAFHT-GRI-.-D-
B.US.SFMHS1	M..GPGKTLYT-.DI-.-D-
B.US.SFMHS11	I..GPG-AFYT-.-I-.-D-
B.US.SFMHS16	I..GPGRAFYT-GEI-.-D-
B.US.SFMHS17	I..APGRAVHT-GEI-.-N-
B.US.SFMHS18	I..GPG-AFYT-G-I-.-D-
B.US.SFMHS19	I..GPGKAIYT-G-I-.-D-
B.US.SFMHS2	I..GPGRAFYT-GEI-.-D-
B.US.SFMHS20	I..GPGRAFYA-GEI-.-D-
B.US.SFMHS21	I..QPGRAFYT-GDI-.-D-
B.US.SFMHS3	I..GPGRAFYT-GEI-.-E-
B.US.SFMHS4	I..GPGKALYT-GEI-.-D-
B.US.SFMHS5	I..GPGRAFYA-G.I-.-D-
B.US.SFMHS6	I..GPGRAFYT-GEI-.-N-
B.US.SFMHS7	M..GPGRAFYT-GDI-.-D-
B.US.SFMHS8	I..GPGRAFYT-GEI-.-D-
B.US.SFMHS9	I..GPGKAFYT-GEI-.-D-
B.US.US1	I..GPGRAIYA-GGI-.-D-
B.US.US2	I..GPGRAFYT-GNI-.-D-
B.US.US3	I..GPGRAFYA-GDI-.-D-
B.US.US4	I..GPGRAFYA-GDI-.-D-
B.US.WC001	I..GPGRAFYT-GDI-.-D-
B.US.WEAU160	L..GPGRVLYT-GEI-.-D-
B.US.WMJ22	I..GPGRAFRT.REI-.-I-
B.US.WR27	H-..--------DRV..-D-
B.US.YU2	I..GPGRALYT-GEI-.-D-
CONSENSUS_C	I..GpGQtfya-gdI-.-d-
C.BI.BU910112	I..GPGQILYA-GDI-.-D-
C.BI.BU910213	I..GPGQTFYAHGAI-.-D-
C.BI.BU910316	I..GPGQTFYA-GDI-.-D-
C.BI.BU910423	I..GPGQAFYA-GDI-.-D-
C.BI.BU910518	I..GPGQAFYA-GDI-.-D-
C.BI.BU910611	I..GPGQTFYA-GDI-.-D-
C.BI.BU910717	I..GPGQTF-A-EDI-.-D-
C.BI.BU910812	I..GPGQAFYA-GEI-.-D-
C.BR.92BR025	I..GPGQAFYA-GEI-.-D-
C.BW.96BW01B03	I..GPGQTFYAAGEI-.-K-
C.BW.96BW0402	I..GPGQTFYA-GEI-.-D-
C.BW.96BW0502	I..GPGQTFYA-GEI-.-D-
C.BW.96BW11B01	I..GPGQTFYA-EAI-.-N-
C.BW.96BW1210	I..GPGQTFYA-GDI-.-D-
C.BW.96BW15B03	I..GPGQTFYA-ENI-.-D-
C.BW.96BW16B01	I..GPGQTF-A-GDI-.-D-
C.BW.96BW17B05	I..GRGQTFYAMGRI-.-DT
C.DJ.DJ259A	I..GPGQTFYA-GDI-.-D-
C.DJ.DJ373A	I..GPGQTFYA-GDI-.-D-
C.ET.ETH2220	I..GPGQTFYA-GDI-.-D-
C.IN.21068	I..GPGQTFYA-GDI-.-D-
C.IN.301904	I..GPGQTFYA-GEI-.-D-
C.IN.301905	I..GPGQTFYA-GDIM.-D-
C.IN.301999	I..GPGQTFYA-GEI-.-D-
C.IN.94IN11246	I..GPGQTFYA-GEIV.-N-
C.SN.SE364A	I..GPGQTFYA-GDI-.-D-
C.SO.SM145A	I..GPGQTFYT.NDI-.-D-
C.UG.UG268A2	I..GPGQTFYA-GDI-.-D-
CONSENSUS_D	p-..-l-q-l---r??.-d-
D.CD.84ZR085	I..GQGQALYT-RYTT.RI-
D.CD.ELI	P-..-L-QSL---RSR.SI-
D.CD.JY1	I..GLGQALYT-R.IK.-D-
D.CD.NDK	GLRQSLYTITGKK-KT.-Y-
D.CD.Z2Z6	S-..-L-Q-L----TR.SI-
D.SN.SE365A2	P-..-L-QVLH--RVK.-D-
D.TZ.87TZ4622	GQGQALYTTRLEP-PT.-K-
D.UG.92UG024D	P-..-L-Q-L---RR-.ED-
D.UG.94UG1141	--..---Q-LF---V-.-D-
D.UG.C971-412	I..GLGQAVYT.S-IA.-YA
D.UG.UG266A2	P-..-R-Q-LF--RRK.-IK
D.UG.UG269A	-..AQGRAWWT-G.IT.-D-
D.UG.UG274A2	.GTGQALYTTQGR-K-.-K-
D.UG.WHO15-474	I..GTGQAPYT-R.I-.-D-
F.BR.BZ126A	F..GPGRAFHTAG-I-.-D-
CONSENSUS_F1	l..GPGq?FYa-GeI-.-D-
F1.BE.VI850	L..GPGQTFYA-GAI-.-D-
F1.BR.93BR020.1	L..GPGRVFYT-GEI-.-D-
F1.FI.FIN9363	I..GPGQSFYA-GEI-.-D-
F1.FR.MP411	L..GPGQAFYA-GDI-.-D-
CONSENSUS_F2	I..GPG??F?A-GEI-.-D?

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F2.CM.MP255          I..GPGQTF-A-GEI-.-D-
F2.CM.MP257          I..GPGRAFYA-GEI-.-DT

CONSENSUS_G          i..GPGQafYa-Gdi-.-d-
G.BE.DRCBL           I..GPGQAFYT-GEV-.-D-
G.FI.HH8793          L..GPGQALYA-GDI-.-N-
G.GA.LBV217          I..GPGQALYA-GAI-.-D-
G.NG.92NG083         I..GPGQAFYA-GDI-.-D-
G.NG.NG1928          F..GPGQAFYA-GDI-.-N-
G.NG.NG1929          F..GPGQAFYA-GEI-.-N-
G.NG.NG1937          I..GPGQAFYA-GAI-.-D-
G.NG.NG1939          I..GPGQAFYA-GDI-.-D-
G.SE.SE6165          I..GPGQTFYA-GAI-.-D-

CONSENSUS_H          ?..GPGqAFYA-GDI-.-d-
H.BE.VI991           I..GPGQAFYA-GDI-.-D-
H.BE.VI997           F..GPGQAFYA-GDI-.-N-
H.CF.90CF056         L..GPGRAFYA-GDI-.-D-

CONSENSUS_J          M..GPGQVLYA-GEI-.-?-
J.SE.SE9173          M..GPGQVLYA-GEI-.-D-
J.SE.SE9280          M..GPGQVLYA-GEI-.-N-

CONSENSUS_K          ?..GPG?AFY?-GDI-.-D-
K.CD.EQTB11C         I..GPGRAFYA-GDI-.-D-
K.CM.MP535           M..GPGKAFYT-GDI-.-D-
N.CM.YBF30           I..GPAMTFYNIE-IV.-D-

CONSENSUS_O          i..gpmawysmglg-n.nns
O.CM.ANT70C          .GPMAWYSMGIGGTAG.NSS
O.CM.CM4974          V..GPMAWYSIAPNDL.NNS
O.CM.HIV1CA9EN       .GPLAWYSMGIEKNSK.NSS
O.CM.MVP5180         PMRWRSMTLKRSNNTS.PRS
O.GA.VI686           ..GPMAWYSMGLEE-K.TNS
O.GQ.193HA           ..GPLAVYSYSLGVEN.I-S
O.GQ.276HA           ..GPMAWYSMGLG-GN.NNT
O.GQ.341HA           .GPLAWYSMGLAGG-N.NNT
O.GQ.655HA           ...................
AC.IN.21301          I..GPGQTFYT.SNI-.-D-
AC.RW.92RW009        I..GPGQAFYA-GDV-.-D-
AC.SE.SE9488         I..GPGQAFYA-GDIT.-D-
AC.ZM.ZAM174         I..GPGQTFYA-.DI-.-D-
AC.ZM.ZAM184         F..GPGQAFYT.NDI-.-D-
AC.ZM.ZAM716-3       I..GPGQAFYT-GAI-.-D-
ACD.SE.SE8603        I..GPGQAFYA-GAIT.-D-
AD.KE.K124A2         I..GPGQAF-A-GDI-.-N-
AD.SE.SE6954         I..GPGQALYV-GGI-.-D-
AD.SE.SE7108         M..GPGKVFYA-GDI-.-D-
AD.UG.C6080-10       I..GLGQALYT-RYTT.-D-
AD.UG.UG/92/035      I..GPGRAL-T-.DI-.-D-
ADHU.NO.NOGIL3       I..GPGQAFYAAEPV-.-D-
ADU.CD.MAL           F..GPGQALYT-G.IV.-D-
AG.GA.VI191A2        I..GPGRAFYA-GQIT.-D-
AG.NG.G3             I..GPGQAFYA-GEI-.-..
AG.SE.SE7812         I..GPGQTFYA-GDI-.-D-
AGHU.GA.VI354        I..GPGRVIYA-SAIT.-D-
AGJ.AU.BFP90         F..GPGQAFIA-GDI-.-D-
AGJ.ML.95ML84        L..GPGQAFYA-GDI-.-D-
AGJ.NG.NG3670        F..GPGQAFYA-GDI-.-D-
AGU.CD.Z321          I..GPGRALYPEGDI-.-D-
AU.NG.NG3678         I..GPGQAFYA-GEI-.-D-
BF.BR.93BR029.4      I..GPGRAFYT-GEI-.-D-
CD.BI.BU910905       H-..-L---Y---GVE.-KK
CRF01_AE.CF.90CF402  I..GPGRVFHT-GNIN.-D-
CRF01_AE.TH.93TH253  I..GQGRVLYR-GDIT.-N-
CRF01_AE.TH.A01021.  I..GPGHVFYK-GEIT.-D-
CRF01_AE.TH.070703   I..GPGQVFYR-GDV-.-D-
CRF01_AE.TH.070704   I..GPGQAFYK-GDI-.-D-
CRF01_AE.TH.070705   I..GPGQVFYK-GDIV.-D-
CRF01_AE.TH.070707   I..GPGQVFYR-GDI-.-D-
CRF01_AE.TH.070708   I..GPGQVFYR-GDI-.-D-
CRF01_AE.TH.070709   I..GPGQVFYK-GDI-.-D-
CRF01_AE.TH.070710   I..GPGQVFYR-GDI-.-D-
CRF01_AE.TH.070711   I..GPGRVFYR-REI-.-D-
CRF01_AE.TH.070713   I..GPGQVFYK-GDI-.-D-
CRF01_AE.TH.CM240    I..GPGRVFYR-GDI-.-N-
CRF01_AE.TH.E11429.  I..GPGRVFYR-GDI-.-D-
CRF01_AE.TH.KH03     I..GPGRVFYK-GNIM.-DR
CRF01_AE.TH.KH08     I..GPGRVFHR-GAIL.-D-
CRF01_AE.TH.TH022    M..GPARVYHR-GDV-.-D-
CRF01_AE.TH.TH047    I..GPGKVFYS-G-IT.-D-
CRF01_AE.TH.TH92014  I..GPGQVFYR-GDI-.-D-
CRF01_AE.TH.TH92111  I..GPGQVFYR-GDI-.-N-
CRF02_AG.DJ.DJ258A   I..GPGQTFYA-GDI-.-D-
CRF02_AG.FR.DJ263    I..GPGQTFYA-GDI-.-D-
CRF02_AG.FR.DJ264    I..GPGQTFYA-GDI-.-D-
CRF02_AG.NG.IBNG     I..GPGQAFYA-GDI-.-D-
CRF02_AG.NG.NG1921   I..GPGQTFLARGGIM.-D-
CRF02_AG.NG.NG3675   I..GPGQTFYA-GDI-.-D-
CRF03_AB.RU.KAL1532  I..GPGRAFYA-GDIT.-D-
CRF03_AB.RU.KAL681   I..GPGRAFYA-GDIT.-D-
CRF03_AB.UA.UKR9700  I..GPGQTFYA-GDV-.-D-
CRF04_cpx.CY.94CY03  I..GPGLTWYA-GEI-.-D-
CRF04_cpx.GR.97PVCH  I..GPGHTWYA-GNIV.-D-
CRF04_cpx.GR.97PVMY  I..GPGKTW-A-GEV-.-D-
DF.BE.VI961          L..GPGQAFYT-GDI-.-D-
GH.GA.VI525          F..GTGRVLYA-GAI-.-N-
GU.NG.NG3670         I..GPGQAFYA-GDI-.-D-
U.CD.VI1126          I..GPGQTFYA-GDI-.-D-

CONSENSUS_CPZ        Q-..---MT--Nie?v.-Dt
CPZ.CD.CPZANT        I..GPGMTFYNVEIAT.-DT
CPZ.GA.CPZGAB        I..GPGMTFYNIENVV.-DT
CPZ.US.CPZUS         L..GPGMTFYNIP-IV.-DV
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ERYLKDQQLLGF

QUERY	ERYLKDQQLLGF
CONSENSUS_A	----------I
A.GB.MA246	----R---I--I
A.GB.MC108	----------I
A.KE.K89	----R------I
A.KE.Q23-CXC-CG	----R------I
A.NG.NG1935	----------I
A.RW.KIG93	----------I
A.RW.SF1703	----------I
A.SE.SE6594	----------I
A.SE.SE7253	----------I
A.SE.SE7535	----------I
A.SE.SE8131	----------I
A.SE.SE8538	----------I
A.SE.SE8891	----R------I
A.UG.92UG037	----R------I
A.UG.U455	----Q------I
A.UG.UG273A	----R------I
A.UG.UG275A	----R------I
CONSENSUS_B	----------i
B.AU.MBC18	----R------L
B.AU.MBC200	----R------I
B.AU.MBC925	----------I
B.AU.MBCC54	----T------I
B.AU.MBCC98	----R------I
B.AU.MBCD36	----M------I
B.BE.SIMI84	----------I
B.CN.RL42	----------I
B.DE.D31	----R------I
B.DE.HAN	----R------I
B.ES.89SP061	----R-------
B.FR.HXB2	----------I
B.FR.PHI120	----------I
B.FR.PHI133	----G------I
B.FR.PHI146	----------I
B.FR.PHI153	----G------I
B.FR.PHI159	----------I
B.FR.PIH155	----Q------I
B.FR.PIH160	----Q--R---I
B.FR.PIH309	----------I
B.FR.PIH373	----------I
B.FR.PIH374	----------I
B.GA.OYI	----------I
B.GB.AC-46	----------I
B.GB.CAM1	----------I
B.GB.GB8.C1	----------I
B.GB.JB	----------I
B.GB.M23470	----------I
B.GB.M26864	----R------I
B.GB.M30156	----------I
B.GB.M737677	----R------I
B.GB.M737685	----R------I
B.GB.MANC	----Q------I
B.GB.MB314	----------I
B.GB.WB	----Q--R---I
B.JP.ETR	---------M-I
B.JP.JH32	----------I
B.NL.3202A21	----------I
B.NL.68A	----------I
B.NL.ENVVA	----------I
B.NL.ENVVF	-S--R------I
B.NL.ENVVG	----------I
B.NL.H0320-2A12	----------I
B.TH.TH936705	----------I
B.TT.QZ4589	----R------I
B.TW.LM49	----R------I
B.US.85WCIPR54	----------I
B.US.92US657.1	----------I
B.US.ADA	----R------I
B.US.ALA1	----R-----EI
B.US.BC	----------I
B.US.BRVA	----------I
B.US.C26-12.1BH	----R------I
B.US.CDC452	----------
B.US.DH123	----Q------I
B.US.ENVUS-R2	----------I
B.US.JRCSF	---------M-I
B.US.JRFL	----G------I
B.US.M02-3.SW	----------I
B.US.MNCG	----------
B.US.NC7	----------I
B.US.NL43E9	----------I
B.US.NY5CG	----------RI
B.US.P896	----R----M-I
B.US.RF	----R------I
B.US.SC	----R------I
B.US.SC141	KK--RN-----I
B.US.SC14C	----R------I
B.US.SF128A	----R------I
B.US.SF2	----R------I
B.US.SFMHS1	----------I
B.US.SFMHS11	----------I
B.US.SFMHS16	----------I
B.US.SFMHS17	----------I
B.US.SFMHS18	----------I
B.US.SFMHS19	----R------I
B.US.SFMHS2	----R------I
B.US.SFMHS20	----Q------I
B.US.SFMHS21	----R------I
B.US.SFMHS3	----------I
B.US.SFMHS4	---------M-I
B.US.SFMHS5	----------I
B.US.SFMHS6	----------I
B.US.SFMHS7	----V------I
B.US.SFMHS8	----------I
B.US.SFMHS9	----R------I
B.US.US1	----------I
B.US.US2	----------I
B.US.US3	----------I
B.US.US4	----------I
B.US.WC001	----------I
B.US.WEAU160	----------I
B.US.WMJ22	----R------I
B.US.WR27	----R------I
B.US.YU2	----R------I
CONSENSUS_C	----------i
C.BI.BU910112	----------I
C.BI.BU910213	----------I
C.BI.BU910316	----------I
C.BI.BU910423	----R--R---I
C.BI.BU910518	----Q------M
C.BI.BU910611	----------I
C.BI.BU910717	----------I
C.BI.BU910812	----R------I
C.BR.92BR025	----R------I
C.BW.96BW01B03	----------I
C.BW.96BW0402	----------I
C.BW.96BW0502	----------I
C.BW.96BW11B01	----------I
C.BW.96BW1210	----R------I
C.BW.96BW15B03	----------I
C.BW.96BW16B01	----------I
C.BW.96BW17B05	-----G-----I
C.DJ.DJ259A	----------I
C.DJ.DJ373A	----------I
C.ET.ETH2220	--H-R------I
C.IN.21068	----------I
C.IN.301904	----------I
C.IN.301905	----------I
C.IN.301999	----------I
C.IN.94IN11246	----------I
C.SN.SE364A	----------I
C.SO.SM145A	----E------I
C.UG.UG268A2	----Q------I
CONSENSUS_D	-?---------i
D.CD.84ZR085	----------I
D.CD.ELI	----------I
D.CD.JY1	-S---------I
D.CD.NDK	----R------I
D.CD.Z2Z6	----------I
D.SN.SE365A2	----R------I
D.TZ.87TZ4622	-S--R------I
D.UG.92UG024D	-S---------I
D.UG.94UG1141	-S---------I
D.UG.C971-412	-S---------I
D.UG.UG266A2	-S---------I
D.UG.UG269A	-S--G------I
D.UG.UG274A2	----------I
D.UG.WHO15-474	----Q------S
F.BR.BZ126A	----Q------L
CONSENSUS_F1	----------?
F1.BE.VI850	----------I
F1.BR.93BR020.1	----------L
F1.FI.FIN9363	----------L
F1.FR.MP411	----------I
CONSENSUS_F2	----------I

```
F2.CM.MP255           ----------I
F2.CM.MP257           ----------I

CONSENSUS_G           ----------I
G.BE.DRCBL            ----------I
G.FI.HH8793           ----R-----I
G.GA.LBV217           ----Q-----I
G.NG.92NG083          ----------I
G.NG.NG1928           ----------I
G.NG.NG1929           ----------I
G.NG.NG1937           --F-------I
G.NG.NG1939           ----------I
G.SE.SE6165           ----------I

CONSENSUS_H           ----------I
H.BE.VI991            ----------I
H.BE.VI997            ----------I
H.CF.90CF056          ----R-----I

CONSENSUS_J           ----------I
J.SE.SE9173           ----------I
J.SE.SE9280           ----------I

CONSENSUS_K           ----?-----I
K.CD.EQTB11C          ----R-----I
K.CM.MP535            ----------I
N.CM.YBF30            ----R---I-SL

CONSENSUS_O           -tliqn----nl
O.CM.ANT70C           -TL-QN----SL
O.CM.CM4974           -TLIQN--R-NL
O.CM.HIV1CA9EN        -TLIQN----NL
O.CM.MVP5180          -TLIQN--R-NL
O.GA.VI686            -TLIQN----NL
O.GQ.193HA            -TLIQN----NL
O.GQ.276HA            -TLIQN----NL
O.GQ.341HA            -TLIQN----NL
O.GQ.655HA            ..........
AC.IN.21301           ----------I
AC.RW.92RW009         ----R-----I
AC.SE.SE9488          ----------I
AC.ZM.ZAM174          ----Q-----I
AC.ZM.ZAM184          ----Q-----I
AC.ZM.ZAM716-3        ----Q-----I
ACD.SE.SE8603         ----------I
AD.KE.K124A2          -S--------I
AD.SE.SE6954          ----------I
AD.SE.SE7108          ----------I
AD.UG.C6080-10        --C-------I
AD.UG.UG/92/035       -S--R-----I
ADHU.NO.NOGIL3        ----------I
ADU.CD.MAL            ----Q--R---M
AG.GA.VI191A2         ----R-----I
AG.NG.G3              ----------I
AG.SE.SE7812          -A--------I
AGHU.GA.VI354         ----------I
AGJ.AU.BFP90          ----------I
AGJ.ML.95ML84         ----------I
AGJ.NG.NG3670         ----R-----L
AGU.CD.Z321           ----------I
AU.NG.NG3678          ----------I
BF.BR.93BR029.4       ----------L
CD.BI.BU910905        ----------I
CRF01_AE.CF.90CF402   -------KF--L
CRF01_AE.TH.93TH253   -------KF--L
CRF01_AE.TH.A01021.   -------KF--L
CRF01_AE.TH.070703    -----N-KF--L
CRF01_AE.TH.070704    -------KF--L
CRF01_AE.TH.070705    -------KF--L
CRF01_AE.TH.070707    xxT$#--KF--L
CRF01_AE.TH.070708    -------KF--L
CRF01_AE.TH.070709    -------KF--L
CRF01_AE.TH.070710    -------KF--L
CRF01_AE.TH.070711    -------KF--L
CRF01_AE.TH.070713    -------KF--L
CRF01_AE.TH.CM240     -------KF--L
CRF01_AE.TH.E11429.   -------KF--L
CRF01_AE.TH.KH03      -------KF--L
CRF01_AE.TH.KH08      -------RF--L
CRF01_AE.TH.TH022     -------KF--L
CRF01_AE.TH.TH047     -------KF--L
CRF01_AE.TH.TH92014   -------KF--L
CRF01_AE.TH.TH92111   -------KF--L
CRF02_AG.DJ.DJ258A    -S--R-----I
CRF02_AG.FR.DJ263     -S--R-----I
CRF02_AG.FR.DJ264     ----R-----I
CRF02_AG.NG.IBNG      ----R-----I
CRF02_AG.NG.NG1921    -G--R-----I
CRF02_AG.NG.NG3675    ----R-----I
CRF03_AB.RU.KAL1532   ----------I
CRF03_AB.RU.KAL681    ----------I
CRF03_AB.UA.UKR9700   ----------I
CRF04_cpx.CY.94CY03   -S---------I
CRF04_cpx.GR.97PVCH   -S---------I
CRF04_cpx.GR.97PVMY   -S--R-----I
DF.BE.VI961           ----R-----L
GH.GA.VI525           --F-----P--I
GU.NG.NG3670          ----------I
U.CD.VI1126           ----------I

CONSENSUS_CPZ         ----?---i--L
CPZ.CD.CPZANT         -K--R-----SL
CPZ.GA.CPZGAB         ----Q---I--L
CPZ.US.CPZUS          --------I--L
```

EVLKYWWNLLQYWSQELKSS

QUERY	EVLKYWWNLLQYWSQELKSS
CONSENSUS_A	-G---L----l--gr---i-
A.GB.MA246	-G---LG---L--GR--RI-
A.GB.MC108	-G---LG---S--GR---I-
A.KE.K89	-G---L----L--G----I-
A.KE.Q23-CXC-CG	-GI--L----S--GR---I-
A.NG.NG1935	QG---LG--V--------N-
A.RW.KIG93	-G---L----L--GR---I-
A.RW.SF1703	-G---L----L--GR---N-
A.SE.SE6594	-G---LG---L--GR---I-
A.SE.SE7253	-G---LG---L--G----L-
A.SE.SE7535	-G---L----L--GR-----
A.SE.SE8131	.G---LG---L--IR---I-
A.SE.SE8538	-G---L----V--IR---I-
A.SE.SE8891	-G---LK---S--GR---L-
A.UG.92UG037	-G---LG---L--GR---I-
A.UG.U455	-G---L----L--GR---I-
A.UG.UG273A	-GI--L----LF-GR---I-
A.UG.UG275A	.G---L----A--GR---I-
CONSENSUS_B	-a----------------n-
B.AU.MBC18	-A----------R---QK-
B.AU.MBC200	----------------N-
B.AU.MBC925	-A----------------N-
B.AU.MBCC54	-A----------G---QK-
B.AU.MBCC98	-A----------------K-
B.AU.MBCD36	-A--------K------QK-
B.BE.SIMI84	-I----------------N-
B.CN.RL42	---R---------I----N-
B.DE.D31	----------------N-
B.DE.HAN	----------------N-
B.ES.89SP061	-A----------I----N-
B.FR.HXB2	-A----------------N-
B.FR.PHI120	-A---L-------I----N-
B.FR.PHI133	-A---L-----------K-
B.FR.PHI146	----------P-R-----N-
B.FR.PHI153	-G----------------N-
B.FR.PHI159	-L----------R-------
B.FR.PIH155	-T----------------N-
B.FR.PIH160	GI---------------QK-
B.FR.PIH309	-I----G------G----N-
B.FR.PIH373	-I----------------N-
B.FR.PIH374	-A---L-----------N-
B.GA.OYI	----------------N-
B.GB.AC-46	-A--------R-------N-
B.GB.CAM1	-A--------------RN-
B.GB.GB8.C1	-A----------I----N-
B.GB.JB	-I----------------N-
B.GB.M23470	----------------N-
B.GB.M26864	-A----------GK-----
B.GB.M30156	-I----------------K-
B.GB.M737677	-I----------G---RN-
B.GB.M737685	-A----------------N-
B.GB.MANC	-I-------------V--N-
B.GB.MB314	-A---L-----------N-
B.GB.WB	-A----------------N-
B.JP.ETR	-----L-----------N-
B.JP.JH32	-A----------------N-
B.NL.3202A21	----------------N-
B.NL.68A	-I----------------N-
B.NL.ENVVA	----------H-------N-
B.NL.ENVVF	-----R-------G--I-N-
B.NL.ENVVG	----------------N-
B.NL.H0320-2A12	-------------G--I-N-
B.TH.TH936705	-A-R--$------I----N-
B.TT.QZ4589	-A----GS----------Y-
B.TW.LM49	-A---L-------I----N-
B.US.85WCIPR54	----------------N-
B.US.92US657.1	-I--------L-------N-
B.US.ADA	----------------RN-
B.US.ALA1	----------------N-
B.US.BC	-A-----S----------N-
B.US.BRVA	----------------N-
B.US.C26-12.1BH	-I----------G--I-N-
B.US.CDC452	----------------N-
B.US.DH123	-L---L-----------N-
B.US.ENVUS-R2	-I----------------N-
B.US.JRCSF	-I----------------N-
B.US.JRFL	----------------N-
B.US.M02-3.SW	-A----G--I---I----K-
B.US.MNCG	----------
B.US.NC7	-A-----S----------N-
B.US.NL43E9	-A----------------N-
B.US.NY5CG	-A---C-------G----N-
B.US.P896	-A----------------N-
B.US.RF	-A----------------N-
B.US.SC	-A----------------RN-
B.US.SC141	-A----------$--K--N-
B.US.SC14C	-A----------------N-
B.US.SF128A	----------------N-
B.US.SF2	-A-----S-----I----N-
B.US.SFMHS1	----------------N-
B.US.SFMHS11	--------I---------N-
B.US.SFMHS16	-A----------------D-
B.US.SFMHS17	-I----------------N-
B.US.SFMHS18	-A-R--------------N-
B.US.SFMHS19	-L----------------N-
B.US.SFMHS2	-A----G-----------N-
B.US.SFMHS20	KI----------------N-
B.US.SFMHS21	GI-----S----------N-
B.US.SFMHS3	-A----------------N-
B.US.SFMHS4	----------------N-
B.US.SFMHS5	-I----------------N-
B.US.SFMHS6	-A-----------G----N-
B.US.SFMHS7	-A----------------N-
B.US.SFMHS8	-A-----------G---QN-
B.US.SFMHS9	-A----------------RN-
B.US.US1	-A----------------T-
B.US.US2	-A----------------N-
B.US.US3	-A----------------N-
B.US.US4	-P----------------
B.US.WC001	----------------N-
B.US.WEAU160	-A---C-----------N-
B.US.WMJ22	-A----------K---N-
B.US.WR27	-I----G------G---RN-
B.US.YU2	G----------I----N-
CONSENSUS_C	-a---LGs-v---gl---k-
C.BI.BU910112	-I---LGS-V---GL---K-
C.BI.BU910213	-T---LGS-V----L---K-
C.BI.BU910316	-I---LG-IV---GL---R-
C.BI.BU910423	-I---LGS-V---GL---K-
C.BI.BU910518	-I---LGS-V---GL---K-
C.BI.BU910611	-I---LGS-V---GL---K-
C.BI.BU910717	-I---LGS-V---GL---K-
C.BI.BU910812	-I---LGS-V---GL---K-
C.BR.92BR025	-I---LGG-V----L---K-
C.BW.96BW01B03	-T---LG--VL--GL---K-
C.BW.96BW0402	-T--FLGS-V---GL---K-
C.BW.96BW0502	-A---LGS-V---GL---K-
C.BW.96BW11B01	-I---LGS-V---GL---M-
C.BW.96BW1210	-A---LGS-V---GL---K-
C.BW.96BW15B03	-A---LGS-V---GL---K-
C.BW.96BW16B01	-A---LGS-V---GL---K-
C.BW.96BW17B05	-A---LGS-G---G----K-
C.DJ.DJ259A	-T---LGS-V---GL---K-
C.DJ.DJ373A	-T---LGS-V---GL---K-
C.ET.ETH2220	-T---LGS-V---GL---K-
C.IN.21068	-A---LGS-V---GL---K-
C.IN.301904	-A---LGS-V---GL---K-
C.IN.301905	-G---LGS-V---GL---K-
C.IN.301999	-A---LGS-V---GI---R-
C.IN.94IN11246	-A---LGS-V---GL---K-
C.SN.SE364A	-I---LGS-A---GL-I-K-
C.SO.SM145A	-A---LG--G---GL---K-
C.UG.UG268A2	-A---LGS-V---G----K-
CONSENSUS_D	-ai--l-------i----N-
D.CD.84ZR085	-A---L--------R---N-
D.CD.ELI	DI---L----------RN-
D.CD.JY1	-AI--L-S-----T----N-
D.CD.NDK	-A---L----------RN-
D.CD.Z2Z6	-A---L--------R---N-
D.SN.SE365A2	-----L-S-----I-K--N-
D.TZ.87TZ4622	-TI--L-------I----N-
D.UG.92UG024D	-AI--L-------I----N-
D.UG.94UG1141	-AI--L-------I----N-
D.UG.C971-412	-AI--L-------I----N-
D.UG.UG266A2	-A----------I----N-
D.UG.UG269A	-AI--L----K--I----N-
D.UG.UG274A2	KAI--L-------I----N-
D.UG.WHO15-474	-AIR-L-S--K--I----N-
F.BR.BZ126A	-A--LLG--TL--G----N-
CONSENSUS_F1	-a---Lg--t--------N-
F1.BE.VI850	-A---LG--TR-------N-
F1.BR.93BR020.1	-A---LG--T---G----N-
F1.FI.FIN9363	-A---LG-II--------N-
F1.FR.MP411	-T---L---A--------N-
CONSENSUS_F2	-?---L---?-?-G?---N-

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F2.CM.MP255           -A---L---T-H-GR---N-
F2.CM.MP257           -----L---A---G----N-

CONSENSUS_G           -g---L----l--g----N-
G.BE.DRCBL            -A---L----L--AR---N-
G.FI.HH8793           -G---L----L--GR---N-
G.GA.LBV217           -G---L----L--G----N-
G.NG.92NG083          -G---L----L--GR---N-
G.NG.NG1928           -G---L----V--G----N-
G.NG.NG1929           -S---L----V--G----N-
G.NG.NG1937           -G---L----L--G----N-
G.NG.NG1939           -G---L----V-------N-
G.SE.SE6165           -G---L----L--GR---N-

CONSENSUS_H           -A---L-------G----N-
H.BE.VI991            -A--LLG---L--G----N-
H.BE.VI997            -A---L-------G----N-
H.CF.90CF056          -A---L-------G----N-

CONSENSUS_J           -I---LV--VW--G----N-
J.SE.SE9173           -I---LV--VW--G----N-
J.SE.SE9280           -I---LV--VW--G----N-

CONSENSUS_K           -A---L---??--?--?-N-
K.CD.EQTB11C          -A---L---IL--G--I-N-
K.CM.MP535            -A---L---V--------N-
N.CM.YBF30            -LRTHL-GI-A--GK--RD-

CONSENSUS_O           nacricaavt---l---qn-
O.CM.ANT70C           N-CRICAAVT---L---QN-
O.CM.CM4974           -ACRLCGAVT---L----T-
O.CM.HIV1CA9EN        NACRVCIAVI---L---QN-
O.CM.MVP5180          -ACRLCGAVM---L----N-
O.GA.VI686            SACRICAAVT-F-L---QN-
O.GQ.193HA            SACRVCAAVT---I---QN-
O.GQ.276HA            D-CRICAAVT---L---QN-
O.GQ.341HA            N-CRICAAVT---L---QN-
O.GQ.655HA            ....................
AC.IN.21301           -G---L----V--GR---I-
AC.RW.92RW009         -T---LG--V---GL---R-
AC.SE.SE9488          -G---L----L--GR--RI-
AC.ZM.ZAM174          -G--HL----L--G----N-
AC.ZM.ZAM184          -G--HL----L--G----N-
AC.ZM.ZAM716-3        -A--HL----L--G----N-
ACD.SE.SE8603         -AI--L-------I----N-
AD.KE.K124A2          -A---LG------TR---N-
AD.SE.SE6954          -A---L-------I----N-
AD.SE.SE7108          -A---L-------I----I-
AD.UG.C6080-10        -G---LK---A--GR---I-
AD.UG.UG/92/035       -G---LG---L--GR---I-
ADHU.NO.NOGIL3        -T---LG---L--G----N-
ADU.CD.MAL            -A---L-------G----N-
AG.GA.VI191A2         -A---L----L--GR---I-
AG.NG.G3              -G---L----L--GR---N-
AG.SE.SE7812          -A---L----S--G----N-
AGHU.GA.VI354         GA---L----L--G------
AGJ.AU.BFP90          -I---LG--IC--G---QN-
AGJ.ML.95ML84         -I---L---VC--G----N-
AGJ.NG.NG3670         -I---LG--VC--G----N-
AGU.CD.Z321           -T---LG--VI--G----N-
AU.NG.NG3678          QI---LG--V---G----T-
BF.BR.93BR029.4       -A--LLG--AL-------N-
CD.BI.BU910905        -T---LGS-V---GL---K-
CRF01_AE.CF.90CF402   -G---LG---S--V---RI-
CRF01_AE.TH.93TH253   -G---LG---L--G----I-
CRF01_AE.TH.A01021.   -G---LG---L--G----I-
CRF01_AE.TH.070703    -G---LK---I--G----I-
CRF01_AE.TH.070704    -G---LG---I-------I-
CRF01_AE.TH.070705    -G---LG---L--G----I-
CRF01_AE.TH.070707    -G---LG---L--G----I-
CRF01_AE.TH.070708    -G---LG---V--G----I-
CRF01_AE.TH.070709    -G---LG---L--G----Tx
CRF01_AE.TH.070710    -G---LG---L--G----I-
CRF01_AE.TH.070711    -G---LG---L--G----I-
CRF01_AE.TH.070713    -G---LG---A--G----I-
CRF01_AE.TH.CM240     -G---LG---L--G----I-
CRF01_AE.TH.E11429.   -G---LG---L--G----I-
CRF01_AE.TH.KH03      -G---LG---A-------T-
CRF01_AE.TH.KH08      -G---LG---A-------I-
CRF01_AE.TH.TH022     -G---L----V--G----I-
CRF01_AE.TH.TH047     -G---LG---L--G----I-
CRF01_AE.TH.TH92014   -G---LG---L--G----I-
CRF01_AE.TH.TH92111   -G---LG---L--G----I-
CRF02_AG.DJ.DJ258A    -A-Q-LG---L--G----N-
CRF02_AG.FR.DJ263     -A-Q-LG---L--G----N-
CRF02_AG.FR.DJ264     -A---LG---T--G----N-
CRF02_AG.NG.IBNG      GA---L---IS--V----N-
CRF02_AG.NG.NG1921    -A---LG---L--G----N-
CRF02_AG.NG.NG3675    -A--VLG---S--G----N-
CRF03_AB.RU.KAL1532   -A----------I------
CRF03_AB.RU.KAL681    -A----------I------
CRF03_AB.UA.UKR9700   -G---LG---G--G------
CRF04_cpx.CY.94CY03   -A---L--F-L--G----N-
CRF04_cpx.GR.97PVCH   -A---L----L--G---RN-
CRF04_cpx.GR.97PVMY   GT---L----L--G--IR--
DF.BE.VI961           -A---L-S----------N-
GH.GA.VI525           -A---L-------G----N-
GU.NG.NG3670          -I---LG--AL--G----N-
U.CD.VI1126           -I---L-S-V---G----N-

CONSENSUS_CPZ         -??????g?i?--??---?-
CPZ.CD.CPZANT         ....................
CPZ.GA.CPZGAB         -R-CLLGGII---GK---I-
CPZ.US.CPZUS          -LRARC-GVIA--AR---V-
```

LHIPTRIRQGLERALL

QUERY	LHIPTRIRQGLERALL
CONSENSUS_A	-n--r-----f-----
A.GB.MA246	-N--R-----F-----
A.GB.MC108	-N--R-----F-----
A.KE.K89	----R-----F-----
A.KE.Q23-CXC-CG	----V-----------
A.NG.NG1935	-N--R-----------
A.RW.KIG93	-N--R-----A----I
A.RW.SF1703	-N--R-----F-----
A.SE.SE6594	----R-----F-----
A.SE.SE7253	-N--R-----F-E---
A.SE.SE7535	----R-----F-----
A.SE.SE8131	----R-----F-----
A.SE.SE8538	----V-----F-----
A.SE.SE8891	F-#-R-SK---K---Q
A.UG.92UG037	-N--R-----F-----
A.UG.U455	-N--R-----------
A.UG.UG273A	-N--R-----F-----
A.UG.UG275A	----R-----F-----
CONSENSUS_B	----r-----------
B.AU.MBC18	----R-----------
B.AU.MBC200	----R-----------
B.AU.MBC925	I---------F-----
B.AU.MBCC54	----R-------M---
B.AU.MBCC98	--V-R-----F---M-
B.AU.MBCD36	----R-------M---
B.BE.SIMI84	----R-----F-----
B.CN.RL42	----------------
B.DE.D31	----V-----------
B.DE.HAN	----R-V---------
B.ES.89SP061	----R----------Q
B.FR.HXB2	R---R--------I--
B.FR.PHI120	--V-R--------L--
B.FR.PHI133	----R--------L--
B.FR.PHI146	R---R-V---------
B.FR.PHI153	----R-V--------Q
B.FR.PHI159	-N--V-----------
B.FR.PIH155	----V-----------
B.FR.PIH160	------V---------
B.FR.PIH309	R---R--------C--
B.FR.PIH373	----------F-----
B.FR.PIH374	I---------------
B.GA.OYI	-N--R-----------
B.GB.AC-46	----R--------S--
B.GB.CAM1	----R--------L--
B.GB.GB8.C1	---------------Q
B.GB.JB	I---V-----------
B.GB.M23470	......--E--------
B.GB.M26864	----R----------Q
B.GB.M30156	----R--------G--
B.GB.M737677	----V-----------
B.GB.M737685	----R------GL---
B.GB.MANC	----V-----------
B.GB.MB314	-N---------------
B.GB.WB	----R-----------
B.JP.ETR	----VK----------
B.JP.JH32	----------------
B.NL.3202A21	----V-----------
B.NL.68A	----R-----------
B.NL.ENVVA	R---R-V---------
B.NL.ENVVF	----V-----------
B.NL.ENVVG	----V-----------
B.NL.H0320-2A12	----------------
B.TH.TH936705	----------FK----
B.TT.QZ4589	----R-----F-----
B.TW.LM49	----------------
B.US.85WCIPR54	----------------
B.US.92US657.1	----------------
B.US.ADA	----------L--
B.US.ALA1	----R-----F-----
B.US.BC	----R--------L--
B.US.BRVA	----R----------Q
B.US.C26-12.1BH	--T-R--------L--
B.US.CDC452	----R-----F-----
B.US.DH123	-N---------------
B.US.ENVUS-R2	----------------
B.US.JRCSF	----------------
B.US.JRFL	----------------
B.US.M02-3.SW	----R-----------
B.US.MNCG	----------------
B.US.NC7	----R--------F--
B.US.NL43E9	R---R--------I--
B.US.NY5CG	----R--------L--
B.US.P896	RN---------------
B.US.RF	----R-----------
B.US.SC	---------------Q
B.US.SC141	----A-----------
B.US.SC14C	----A-----------
B.US.SF128A	----R-V---------
B.US.SF2	---HR---------L--
B.US.SFMHS1	----R-V---------
B.US.SFMHS11	----------------
B.US.SFMHS16	----R$T--------Q
B.US.SFMHS17	P---R-----------
B.US.SFMHS18	---------------Q
B.US.SFMHS19	---------------Q
B.US.SFMHS2	----V-----------
B.US.SFMHS20	----------------
B.US.SFMHS21	----R---P-------
B.US.SFMHS3	R---V-----------
B.US.SFMHS4	-----G----------
B.US.SFMHS5	----------------
B.US.SFMHS6	----R-V------I--
B.US.SFMHS7	----------------
B.US.SFMHS8	-R--A-V-----GT--
B.US.SFMHS9	-N--R--------L--
B.US.US1	----------------
B.US.US2	CN--R--------L--
B.US.US3	-------------L--
B.US.US4	I---R-----------
B.US.WC001	----------------
B.US.WEAU160	----R-----------
B.US.WMJ22	I---R-----------
B.US.WR27	----R--------V--
B.US.YU2	----V-----------
CONSENSUS_C	rn--r-----f-a--q
C.BI.BU910112	Y---R-----F-A--Q
C.BI.BU910213	YN--R-----F-A--Q
C.BI.BU910316	YN--R-------A--Q
C.BI.BU910423	YN--R-------A--Q
C.BI.BU910518	YN--R-----F-A--Q
C.BI.BU910611	CS--R-----F-A--Q
C.BI.BU910717	CN--------F-A--Q
C.BI.BU910812	CN--R-----F-A---
C.BR.92BR025	CN--R-----F-A--Q
C.BW.96BW01B03	RN--R----CF-A--Q
C.BW.96BW0402	CN--------F-A--Q
C.BW.96BW0502	RN--R-----F-A--Q
C.BW.96BW11B01	RNT-R-----F-T---
C.BW.96BW1210	RN--R-----F-A--Q
C.BW.96BW15B03	CN--R-V---F-A--Q
C.BW.96BW16B01	RN--R-L---F-A--Q
C.BW.96BW17B05	-N----------A--Q
C.DJ.DJ259A	CN--R-----F-A--Q
C.DJ.DJ373A	CN--R-----F-A--Q
C.ET.ETH2220	CN--R-------A--Q
C.IN.21068	RN--R-----F-A--Q
C.IN.301904	RN--R-----F-AV-Q
C.IN.301905	RN--R-----F-A--Q
C.IN.301999	RN--------F-I--Q
C.IN.94IN11246	RN--R-------A--Q
C.SN.SE364A	SN--R-----F-A--Q
C.SO.SM145A	RN--------F-A---
C.UG.UG268A2	----R-----F-A--Q
CONSENSUS_D	-n--------------
D.CD.84ZR085	----------------
D.CD.ELI	-N--R--------S--
D.CD.JY1	----R-V---------
D.CD.NDK	-NV-R--------L--
D.CD.Z2Z6	-------------L--
D.SN.SE365A2	----------------
D.TZ.87TZ4622	-N-------S------
D.UG.92UG024D	-N-----------L--
D.UG.94UG1141	-N--V-----------
D.UG.C971-412	-N--R-------G---
D.UG.UG266A2	-N--------F-----
D.UG.UG269A	----R-----F-----
D.UG.UG274A2	-N--------------
D.UG.WHO15-474	RN--R-----------
F.BR.BZ126A	-N--------F-----
CONSENSUS_F1	-N--R-----------
F1.BE.VI850	-N--R-----A-----
F1.BR.93BR020.1	-N--R-----------
F1.FI.FIN9363	-N--R----RV----I
F1.FR.MP411	-NV-R--------S--
CONSENSUS_F2	-?--R-----?--?--

```
F2.CM.MP255          ----R-----A--F--
F2.CM.MP257          -N--R-----------

CONSENSUS_G          -N--r-----------
G.BE.DRCBL           -N--R-----------
G.FI.HH8793          -N--------------
G.GA.LBV217          -N--R-----------
G.NG.92NG083         -NV-------------
G.NG.NG1928          -N--R-----------
G.NG.NG1929          -N--R-----------
G.NG.NG1937          -N--R-----A----Q
G.NG.NG1939          -NV-R-V---------
G.SE.SE6165          -N--------------

CONSENSUS_H          ----R-----f--?--
H.BE.VI991           ----R-----F-----
H.BE.VI997           ----R--------I--
H.CF.90CF056         ----R-----F--S--

CONSENSUS_J          ----R-----------
J.SE.SE9173          ----R-----------
J.SE.SE9280          ----R-----------

CONSENSUS_K          ----R-----?--?--
K.CD.EQTB11C         ----R-----F--L--
K.CM.MP535           ----R-----------
N.CM.YBF30           ----R----------I

CONSENSUS_O          ?n--r--------i--
O.CM.ANT70C          RN--R--------S--
O.CM.CM4974          -N--R-----A--F--
O.CM.HIV1CA9EN       -N--R--------G--
O.CM.MVP5180         ----R-----A--I-V
O.GA.VI686           RN-----------S--
O.GQ.193HA           WN--R--------I--
O.GQ.276HA           CNV-R--------I--
O.GQ.341HA           RNV-R--------I--
O.GQ.655HA           ................
AC.IN.21301          ----R-----------
AC.RW.92RW009        YN--S-----F-A--Q
AC.SE.SE9488         -N--R-----F-----
AC.ZM.ZAM174         RNT-R-----F-A---
AC.ZM.ZAM184         RN--------F-----
AC.ZM.ZAM716-3       RNT-R-----F-T---
ACD.SE.SE8603        -NT-R-----------
AD.KE.K124A2         ----R-----F-----
AD.SE.SE6954         -R--A--------V--
AD.SE.SE7108         ----R-----------
AD.UG.C6080-10       -N--------F-----
AD.UG.UG/92/035      -N--------------
ADHU.NO.NOGIL3       ----R-----F--x--
ADU.CD.MAL           ----R-----F-----
AG.GA.VI191A2        -N--R-----A-K--Q
AG.NG.G3             -N--R-----------
AG.SE.SE7812         -N--R-----F-----
AGHU.GA.VI354        -N--R----------I
AGJ.AU.BFP90         -NV-R-----F-----
AGJ.ML.95ML84        -N--R-----A----I
AGJ.NG.NG3670        -N--R-----------
AGU.CD.Z321          -N--R-----------
AU.NG.NG3678         -NV-R-T---F-----
BF.BR.93BR029.4      -NV-R-----------
CD.BI.BU910905       CN--R-----F-A--Q
CRF01_AE.CF.90CF402  ----R-----------
CRF01_AE.TH.93TH253  ----R-----------
CRF01_AE.TH.A01021.  ----R--------S--
CRF01_AE.TH.070703   ----R-----------
CRF01_AE.TH.070704   ----R----------I
CRF01_AE.TH.070705   ----R-----------
CRF01_AE.TH.070707   ----R-----------
CRF01_AE.TH.070708   ----K-----------
CRF01_AE.TH.070709   --V-KK----------
CRF01_AE.TH.070710   ----R-----A----Q
CRF01_AE.TH.070711   ----R--------S--
CRF01_AE.TH.070713   ----R-----F-----
CRF01_AE.TH.CM240    ----R--------T--
CRF01_AE.TH.E11429.  ----R--------I--
CRF01_AE.TH.KH03     ----R-----------
CRF01_AE.TH.KH08     I---R----------Q
CRF01_AE.TH.TH022    ----R-----------
CRF01_AE.TH.TH047    ----R-----------
CRF01_AE.TH.TH92014  ----R----------V
CRF01_AE.TH.TH92111  ----R-----------
CRF02_AG.DJ.DJ258A   -N--R-----------
CRF02_AG.FR.DJ263    -N--R-----------
CRF02_AG.FR.DJ264    RN--V-----------
CRF02_AG.NG.IBNG     RN--R-----F-----
CRF02_AG.NG.NG1921   RN--R--------S--
CRF02_AG.NG.NG3675   WN--R-----F-----
CRF03_AB.RU.KAL1532  RN--R-----A-K--Q
CRF03_AB.RU.KAL681   RN--R-----A-K--Q
CRF03_AB.UA.UKR9700  RN--x-----A-K--Q
CRF04_cpx.CY.94CY03  CN--R-----------
CRF04_cpx.GR.97PVCH  RN--R-----F-K-..
CRF04_cpx.GR.97PVMY  -N--R-----------
DF.BE.VI961          -N--R-----------
GH.GA.VI525          ----R-----F-----
GU.NG.NG3670         I---R-----------
U.CD.VI1126          -N--R-----F-----

CONSENSUS_CPZ        ??--r--------?--
CPZ.CD.CPZANT        ..............--
CPZ.GA.CPZGAB        RN--R-----------
CPZ.US.CPZUS         I---R--------S--
```

VPVWKEATTTLFCASDAKAY

QUERY	VPVWKEATTTLFCASDAKAY
CONSENSUS_A	-----d-e----------
A.GB.MA246	-----D-E----------
A.GB.MC108	-----D-E----------
A.KE.K89	-----N-E----------
A.KE.Q23-CXC-CG	----RD-D----------
A.NG.NG1935	-----D-K---------R--
A.RW.KIG93	-----D-E----------
A.RW.SF1703	-----D-E----------
A.SE.SE6594	-----D-E----------
A.SE.SE7253	-----D-E---------Q--
A.SE.SE7535	-----D-E----------
A.SE.SE8131	-----D-E----------
A.SE.SE8538	-----D-E----------
A.SE.SE8891	I---RD-E----------
A.UG.92UG037	--I--D-N----------
A.UG.U455	-----D-V----------
A.UG.UG273A	----RD-E----------
A.UG.UG275A	----RD-E----------
CONSENSUS_B	--------------------
B.AU.MBC18	----R---------------
B.AU.MBC200	----R----------R--
B.AU.MBC925	--------------------
B.AU.MBCC54	----R---------------
B.AU.MBCC98	----R--A----------
B.AU.MBCD36	----R---------------
B.BE.SIMI84	--------------------
B.CN.RL42	--------------------
B.DE.D31	--------------------
B.DE.HAN	--------------------
B.ES.89SP061	--------------------
B.FR.HXB2	--------------------
B.FR.PHI120	--------------------
B.FR.PHI133	--------------------
B.FR.PHI146	-------S----------
B.FR.PHI153	--------------------
B.FR.PHI159	--------------------
B.FR.PIH155	--------------------
B.FR.PIH160	---------------N----
B.FR.PIH309	-------D----------
B.FR.PIH373	-------D----------
B.FR.PIH374	--------------------
B.GA.OYI	-----------------R--
B.GB.AC-46	--------------------
B.GB.CAM1	--------------------
B.GB.GB8.C1	--------------------
B.GB.JB	-----------------V-
B.GB.M23470	----N---------------
B.GB.M26864	-----------------S-
B.GB.M30156	-----------------T-
B.GB.M737677	--------------------
B.GB.M737685	--------------------
B.GB.MANC	------------------H
B.GB.MB314	--------------------
B.GB.WB	--------------------
B.JP.ETR	--------------------
B.JP.JH32	-------A----------
B.NL.3202A21	------------------S
B.NL.68A	--------------------
B.NL.ENVVA	------T-------------
B.NL.ENVVF	--------------------
B.NL.ENVVG	-------N----------
B.NL.H0320-2A12	--------------------
B.TH.TH936705	-------N----------
B.TT.QZ4589	--------------------
B.TW.LM49	------------------T-
B.US.85WCIPR54	--------------------
B.US.92US657.1	-------D----------
B.US.ADA	--------------------
B.US.ALA1	--------------------
B.US.BC	--------------------
B.US.BRVA	-------N----------
B.US.C26-12.1BH	--------------------
B.US.CDC452	--------------------
B.US.DH123	-------N----------
B.US.ENVUS-R2	--------------------
B.US.JRCSF	------T-------------
B.US.JRFL	--------------------
B.US.M02-3.SW	--------------------
B.US.MNCG	--------------------
B.US.NC7	--------------------
B.US.NL43E9	------T----------P--
B.US.NY5CG	--------------------
B.US.P896	----R---------------
B.US.RF	---------------E----
B.US.SC	--------------------
B.US.SC141	---$----------------
B.US.SC14C	------------G-------
B.US.SF128A	------------------S
B.US.SF2	-----------------R--
B.US.SFMHS1	------T--------N----
B.US.SFMHS11	--------------------
B.US.SFMHS16	-----------------E--
B.US.SFMHS17	------------G-------
B.US.SFMHS18	--------------------
B.US.SFMHS19	-------A----------
B.US.SFMHS2	--------------------
B.US.SFMHS20	------------G-------
B.US.SFMHS21	--------------------
B.US.SFMHS3	--------------------
B.US.SFMHS4	---------------N----
B.US.SFMHS5	--------------------
B.US.SFMHS6	--------------------
B.US.SFMHS7	-------N----------
B.US.SFMHS8	--------------------
B.US.SFMHS9	--------------------
B.US.US1	------------G-------
B.US.US2	------------G-------
B.US.US3	------------G-------
B.US.US4	--------------------
B.US.WC001	--------------------
B.US.WEAU160	--------------------
B.US.WMJ22	--------------------
B.US.WR27	--------------------
B.US.YU2	--------------------
CONSENSUS_C	-------k----------
C.BI.BU910112	--------------------
C.BI.BU910213	----Q--K----------
C.BI.BU910316	----RD-K----------
C.BI.BU910423	-------K----------
C.BI.BU910518	-WKEAQPIP----------
C.BI.BU910611	G-------P----------
C.BI.BU910717	-------K----------
C.BI.BU910812	-------K----------
C.BR.92BR025	-------K----------
C.BW.96BW01B03	-------K----------
C.BW.96BW0402	-------KA--------R--
C.BW.96BW0502	-------K-----T------
C.BW.96BW11B01	----R--KA----------
C.BW.96BW1210	-------K----------
C.BW.96BW15B03	----R--SN------Y----
C.BW.96BW16B01	-------K----------
C.BW.96BW17B05	----R--K----------F
C.DJ.DJ259A	-----D-NPP---------
C.DJ.DJ373A	----Q--NP----------
C.ET.ETH2220	-----D-SP----------
C.IN.21068	-------N----------
C.IN.301904	-------K----------
C.IN.301905	-------K----------H
C.IN.301999	-------K----------
C.IN.94IN11246	-------K----------
C.SN.SE364A	-------K----------
C.SO.SM145A	----R--K--------S---
C.UG.UG268A2	--------------------
CONSENSUS_D	-----------------s-
D.CD.84ZR085	-----------------S-
D.CD.ELI	-----------------S-
D.CD.JY1	-----------------S-
D.CD.NDK	--I-----------------
D.CD.Z2Z6	-----------------S-
D.SN.SE365A2	-----------------S-
D.TZ.87TZ4622	-----------------S-
D.UG.92UG024D	-------------------$
D.UG.94UG1141	--------------------
D.UG.C971-412	-----------------S-
D.UG.UG266A2	-----D-E----G-------
D.UG.UG269A	-----------------S-
D.UG.UG274A2	-----------------S-
D.UG.WHO15-474	-----------------S-
F.BR.BZ126A	-----------------S-
CONSENSUS_F1	-----------------s-
F1.BE.VI850	--------------------
F1.BR.93BR020.1	-----------------S-
F1.FI.FIN9363	-------N----------S-
F1.FR.MP411	-----------------G-
CONSENSUS_F2	------?------------

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F2.CM.MP255          ------P------------
F2.CM.MP257          --------------------

CONSENSUS_G          ----Ed-d-?----------
G.BE.DRCBL           ----ED-NAP---------H
G.FI.HH8793          ----ED-K------------
G.GA.LBV217          --A-ED-D------------
G.NG.92NG083         ----ED-D-P--------S-
G.NG.NG1928          ----E--D-P----------
G.NG.NG1929          ----ED-D-S----------
G.NG.NG1937          ----ED-D------P-----
G.NG.NG1939          ----ED-D-P----------
G.SE.SE6165          ----ED-D----------S-

CONSENSUS_H          -------K------------
H.BE.VI991           -------K------------
H.BE.VI997           -------K------------
H.CF.90CF056         -------K------------

CONSENSUS_J          ----?D-K------------
J.SE.SE9173          ----RD-K------------
J.SE.SE9280          -----D-K------------

CONSENSUS_K          --------?----------
K.CD.EQTB11C         --------------------
K.CM.MP535           --------P----------
N.CM.YBF30           ----R--E----------H

CONSENSUS_O          ----ed--PV-------NLT
O.CM.ANT70C          ----ED--PV-------NLT
O.CM.CM4974          -----D--PV-------NLT
O.CM.HIV1CA9EN       ----GD-APV---T--VNLT
O.CM.MVP5180         ----E--APV-------NLT
O.GA.VI686           ----ED-NPV-------NLT
O.GQ.193HA           ----ED--PV-------NLT
O.GQ.276HA           ----ED--PV-------NLT
O.GQ.341HA           ----ED-NPV-------NLT
O.GQ.655HA           ----ED-IPV-------NLT
AC.IN.21301          -----D-E------------
AC.RW.92RW009        -----D-E------------
AC.SE.SE9488         -------K------------
AC.ZM.ZAM174         -------K----------S-
AC.ZM.ZAM184         ----R--K------------
AC.ZM.ZAM716-3       -------K------------
ACD.SE.SE8603        -----D-E------------
AD.KE.K124A2         ----RD-E------------
AD.SE.SE6954         ----RD-E------------
AD.SE.SE7108         -----D-E------------
AD.UG.C6080-10       -----D-K------------
AD.UG.UG/92/035      -----D-E------------
ADHU.NO.NOGIL3       -------K------------
ADU.CD.MAL           ------------------S-
AG.GA.VI191A2        -----D-E------------
AG.NG.G3             ----ED-D-P----------
AG.SE.SE7812         ----RD-E------------
AGHU.GA.VI354        ----RD-K-S--------S-
AGJ.AU.BFP90         --A-ED-D-I----------
AGJ.ML.95ML84        ----ED-D-I----------
AGJ.NG.NG3670        --A-E--D-I----------
AGU.CD.Z321          -----D-E------------
AU.NG.NG3678         -----D-E------------
BF.BR.93BR029.4      --------------------
CD.BI.BU910905       ------------------S-
CRF01_AE.CF.90CF402  ----RD-D-I---------H
CRF01_AE.TH.93TH253  ----RD-D-----------H
CRF01_AE.TH.A01021.  ----RD-D-----------H
CRF01_AE.TH.070703   ----RD-D-----------H
CRF01_AE.TH.070704   ----RD-D-----------H
CRF01_AE.TH.070705   ----RD-D-----------H
CRF01_AE.TH.070707   ----RD-D-----------H
CRF01_AE.TH.070708   ----RD-D-----------H
CRF01_AE.TH.070709   ----RD-N-----------H
CRF01_AE.TH.070710   -----D-N-----------H
CRF01_AE.TH.070711   ----RD-D-----------H
CRF01_AE.TH.070713   ----RD-D-----------H
CRF01_AE.TH.CM240    ----RD-D-----------H
CRF01_AE.TH.E11429.  -----D-D-----------H
CRF01_AE.TH.KH03     ----RD-E-----------H
CRF01_AE.TH.KH08     ----RD-D-----------H
CRF01_AE.TH.TH022    ----RD-D-----------H
CRF01_AE.TH.TH047    ----RD-D-----------H
CRF01_AE.TH.TH92014  -----D-D-----------H
CRF01_AE.TH.TH92111  ----RD-D-----------H
CRF02_AG.DJ.DJ258A   ----RD-K------------
CRF02_AG.FR.DJ263    ----RN-E------------
CRF02_AG.FR.DJ264    ----RD-E------------
CRF02_AG.NG.IBNG     -----T-E------------
CRF02_AG.NG.NG1921   ----RD-D------------
CRF02_AG.NG.NG3675   ----R--E----------G-
CRF03_AB.RU.KAL1532  --------------------
CRF03_AB.RU.KAL681   --------------------
CRF03_AB.UA.UKR9700  ----RD-E------------
CRF04_cpx.CY.94CY03  ----RD-E-------E----
CRF04_cpx.GR.97PVCH  ----RD-E-KPx--------
CRF04_cpx.GR.97PVMY  ----RD-E-SP---------
DF.BE.VI961          -------N----------G-
GH.GA.VI525          ----ED-E-P--------S-
GU.NG.NG3670         -----D-D------------
U.CD.VI1126          -------N----------P-

CONSENSUS_CPZ        ----rd-?p----------?
CPZ.CD.CPZANT        ----RN--P-----TN-SMT
CPZ.GA.CPZGAB        ----HD-DPV---------H
CPZ.US.CPZUS         ----RDVE------------
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GELDRWEKIRLRPGGKKKYK

QUERY	GELDRWEKIRLRPGGKKKYK
CONSENSUS_A	-k--a----------r
A.KE.Q23-CXC-CG	-KF-A----------R
A.SE.SE6594	-K--A----------R
A.SE.SE7253	-K--A----------R
A.SE.SE7535	-K--A----------Q-R
A.SE.SE8131	-K--A----------N---R
A.SE.SE8538	-R--A----------R
A.SE.SE8891	EKK-A---M----------
A.UG.92UG037	-K--A----------R
A.UG.U455	KK--S----------N---R
CONSENSUS_B	--------------------
B.AU.AF128998	-K--K----------T-Q
B.-.NL43E9	----K----------L--
B.AU.MBC18	-K----------
B.AU.MBC200	----------Q-R
B.AU.MBC925	-------R-----R-----Q
B.AU.MBCC54	----------Q
B.AU.MBCC98	----------Q
B.AU.MBCD36	E----------R---Q
B.CN.RL42	-Q----------R
B.DE.D31	----------R
B.DE.HAN	----K----------Q
B.ES.89SP061	-G----------R
B.FR.HXB2	--------------------
B.GA.OYI	----K----------Q
B.GB.CAM1	----K----------
B.GB.MANC	-K----------
B.JP.JH31	--------------------
B.NL.3202A21	----K----------R--
B.TW.LM49	----K--RV----------R
B.US.85WCIPR54	----------
B.US.AD8	-K----------
B.US.BC	-K--K----------
B.US.DH123	-K--S----------
B.US.JRCSF	----------R
B.US.JRFL	-K--K----------R
B.US.MNCG	-------N----------
B.US.NC7	-D----------M
B.US.NY5CG	----K----------Q-R
B.US.P896	--------------------
B.US.RF	-K--K--------R---R--
B.US.SF2	----K----------
B.US.WC001	----------
B.US.WEAU160	----------N----
B.US.WR27	----K----------R
B.US.YU2	----K----------Q-R
CONSENSUS_C	-K--k----------h-m
C.BR.92BR025	-K--A--R-K-K-----H-M
C.BW.96BW01B22	-K--Q----------C-M
C.BW.96BW0402	-K--A----------Q-R
C.BW.96BW0502	EK--K----------H-M
C.BW.96BW1104	-K--T----------R-M
C.BW.96BW1210	EK--T----------R-M
C.BW.96BW15B03	EK--T-----S------C-M
C.BW.96BW1626	-K--K----------R-M
C.BW.96BW17A09	-K--T----------H-M
C.ET.ETH2220	EK--A----K-------H-M
C.IN.93IN904	EK--K----------H-M
C.IN.93IN905	-K--K----------H-M
C.IN.93IN999	EK--K--R---------H-M
C.IN.94IN11246	-K--K----------H-M
C.IN.95IN21068	-K--K----------R-M
CONSENSUS_D	-K--a----------r
D.CD.84ZR085	-K--A----------
D.CD.ELI	-K--K----------R
D.CD.NDK	-K--T--R----------A
D.CD.Z2Z6	-K--A----------R
D.UG.94UG1141	-K--E----------R
CONSENSUS_F	-K--A----------r
F.BR.BZ162	-K--A----------R
F.CD.VI174	-K--A----Q---------R
F.RW.VI69	-K--A----------R----
CONSENSUS_F1	-K--a----------r
F1.BE.VI850	-K--E----Q-------R--
F1.BR.93BR020.1	-K--A----------R
F1.FI.FIN9363	-K--A----------Q-R
F1.FR.MP411	-K--A--R----------R
CONSENSUS_F2	-K--A------?-----?-R
F2.CM.MP255	-K--A------K-----R-R
F2.CM.MP257	-K--A----------R
CONSENSUS_G	-K--A----------x---x
G.BE.DRCBL	-K--A----------R-R
G.FI.HH8793	-K--A----------R
G.NG.92NG083	-K--S----------R----
G.SE.SE6165	-K--A----------R-S--
CONSENSUS_H	-K--A----------R
H.BE.VI991	-K--A----------R---R
H.BE.VI997	-R--TL----------R
H.CF.90CF056	-K--A----------R
CONSENSUS_J	-K--D----------?-R
J.SE.SE9173	-K--D----------Q-R
J.SE.SE9280	-K--D----------R
CONSENSUS_K	-K--?----------r
K.BE.VI325	-K--T----------S---R
K.CD.EQTB11C	-K--K----Q---------R
K.CM.MP535	-K--A----------
N.CM.YBF30	-K--Q--S-Y---------R
CONSENSUS_O	SK--A--?---?--S--?-R
O.CM.ANT70C	SK--A--Q---K--S----R
O.CM.MVP5180	SK--A--R------S--A-R
CRF01-AE.CF.90CF40	-K--A----------Q-R
CRF01-AE.TH.93TH25	-K--A----------
CRF01-AE.TH.CM240	-K--A----------R---R
CRF01-AE.TH.TH022	-K--A----------R---R
CRF01-AE.TH.TH047	-K--A----------R---H
CRF02_AG.FR.DJ263	-K--S----------R
CRF02_AG.FR.DJ264	-K--S--------A-----R
CRF02_AG.NG.IBNG	-K--A----------R
CRF03_AB.RU.KAL15	-K--A----------E--R
CRF04_cpx.CY.94CY0	-K--A--R----------R
CRF04_cpx.GR.97PVC	-K--A--R----------R
CRF04_cpx.GR.97PVM	-R--A----------R-R
AC.ET.E3099G	-K--T----------N---R
AC.IN.21301	-K--K----------H-M
AC.RW.92RW009	-K--A----K-K-----T-M
AC.SE.SE9488	-K--A----------R
AC.ZM.ZAM174-21	-K--T----------S-R-M
AC.ZM.ZAM184	-K--A----------Q-R
AC.ZM.ZAM716-17	-K--A----------Q-R
ACD.SE.SE8603	-K--A----------R
AD.SE.SE6954	ER--E----Q-------R-R
AD.SE.SE7108	-K--A----------R----
ADHU.NO.NOGIL3	-K--K----------Q-R
ADU.CD.MAL	-K--A----------R
AG.NG.G3	-K--A----------R
AG.SE.SE7812	-K--A----------R
AGHU.GA.VI354	-K--A----------Q
AGJ.AU.BFP90	-K--E----------
AGJ.ML.95ML8	-K--E----------R
AGU.CD.Z321	-K--K----------Q--
BF.BR.93BR029.4	----K----------H---R
DF.CD.VI961	-K--A----------R
U.CD.VI1126	-K--S----------R---R
CONSENSUS_CPZ	-k--?----------M
CPZ.CD.CPZANT	EK--T--S----------M
CPZ.GA.CPZGAB	-K------V------R-R-M
CPZ.US.CPZUS	-R--A----------M

LRPGGKKKYKLKHIVWASRE

QUERY	LRPGGKKKYKLKHIVWASRE
CONSENSUS_A	---------r---l------
A.KE.Q23-CXC-CG	---------RM--LI-----
A.SE.SE6594	---------R---L------
A.SE.SE7253	---------RM--L------
A.SE.SE7535	-------Q-R---L------
A.SE.SE8131	-----N---R---L------
A.SE.SE8538	---------RM--L------
A.SE.SE8891	------------M---R--
A.UG.92UG037	---------R---L------
A.UG.U455	-----N---R---L------
CONSENSUS_B	--------------------
B.AU.AF128998	-------T-Q----------
B.-.NL43E9	-------L------I-----
B.AU.MBC18	--------------------
B.AU.MBC200	-------Q-R----------
B.AU.MBC925	---R-----Q----------
B.AU.MBCC54	---------Q----------
B.AU.MBCC98	---------Q----------
B.AU.MBCD36	-----R---Q----------
B.CN.RL42	---------R---L------
B.DE.D31	---------R----------
B.DE.HAN	---------Q----------
B.ES.89SP061	---------R---L------
B.FR.HXB2	--------------------
B.GA.OYI	---------Q----------
B.GB.CAM1	--------------------
B.GB.MANC	--------------------
B.JP.JH31	--------------------
B.NL.3202A21	-------R------------
B.TW.LM49	---------R---L------
B.US.85WCIPR54	--------------------
B.US.AD8	--------------------
B.US.BC	------------L------
B.US.DH123	--------------------
B.US.JRCSF	---------R----------
B.US.JRFL	---------R----------
B.US.MNCG	------------V------
B.US.NC7	---------M----------
B.US.NY5CG	-------Q-R----------
B.US.P896	--------------------
B.US.RF	---R---R------------
B.US.SF2	--------------------
B.US.WC001	--------------------
B.US.WEAU160	-----N--------------
B.US.WR27	---------R---L------
B.US.YU2	-------Q-R----------
CONSENSUS_C	-------h-m---l------
C.BR.92BR025	-K-----H-MM--L------
C.BW.96BW01B22	-------C-M---L------
C.BW.96BW0402	-------Q-RI--L------
C.BW.96BW0502	-------H-M---L------
C.BW.96BW1104	-------R-MI--L------
C.BW.96BW1210	-------R-MM--L------
C.BW.96BW15B03	S------C-M----------
C.BW.96BW1626	-------R-M---L------
C.BW.96BW17A09	-------H-M---L------
C.ET.ETH2220	-------H-M---L---N--
C.IN.93IN904	-------H-M---L------
C.IN.93IN905	-------H-M---L------
C.IN.93IN999	-------H-M---L------
C.IN.94IN11246	-------H-M---L------
C.IN.95IN21068	-------R-M---L------
CONSENSUS_D	---------r---l------
D.CD.84ZR085	--------------------
D.CD.ELI	---------R----------
D.CD.NDK	---------A---LI-----
D.CD.Z2Z6	---------R---L------
D.UG.94UG1141	---------R---L------
CONSENSUS_F	---------rm--L------
F.BR.BZ162	---------R---L------
F.CD.VI174	---------RM--L------
F.RW.VI69	-----R----M--LI-----
CONSENSUS_F1	---------rm--L------
F1.BE.VI850	-------R--M--LI-----
F1.BR.93BR020.1	---------R---L------
F1.FI.FIN9363	-------Q-RI--L------
F1.FR.MP411	---------RM--L------
CONSENSUS_F2	-?-----?-R---?------
F2.CM.MP255	-K-----R-R---L------
F2.CM.MP257	---------R----------
CONSENSUS_G	-----x---xx--L------
G.BE.DRCBL	-------R-RM--L------
G.FI.HH8793	---------R---L------
G.NG.92NG083	-----R--------------
G.SE.SE6165	-----R-S--I--L------
CONSENSUS_H	---------R---L------
H.BE.VI991	-----R---R---L------
H.BE.VI997	---------R----------
H.CF.90CF056	---------R---L------
CONSENSUS_J	-------?-RI--L------
J.SE.SE9173	-------Q-RI--L------
J.SE.SE9280	---------RI--L------
CONSENSUS_K	---------r---L------
K.BE.VI325	-----S---R---L------
K.CD.EQTB11C	---------R---L------
K.CM.MP535	------------L------
N.CM.YBF30	---------RM--L------
CONSENSUS_O	-?--S--?-R---L------
O.CM.ANT70C	-K--S----R---L------
O.CM.MVP5180	----S--A-R---L------
CRF01-AE.CF.90CF40	-------Q-RM--L------
CRF01-AE.TH.93TH25	----------M--L------
CRF01-AE.TH.CM240	-----R---R---L------
CRF01-AE.TH.TH022	-----R---RM--L------
CRF01-AE.TH.TH047	-----R---H----------
CRF02_AG.FR.DJ263	---------R---L------
CRF02_AG.FR.DJ264	---A-----R---L------
CRF02_AG.NG.IBNG	---------R---L------
CRF03_AB.RU.KAL15	------E--RI--L------
CRF04_cpx.CY.94CY0	---------R---L------
CRF04_cpx.GR.97PVC	---------R---L------
CRF04_cpx.GR.97PVM	-------R-RI--LI-----
AC.ET.E3099G	-----N---R---L------
AC.IN.21301	-------H-MI--L------
AC.RW.92RW009	-K-----T-MM--L------
AC.SE.SE9488	---------RM--L------
AC.ZM.ZAM174-21	-----S-R-MI--L------
AC.ZM.ZAM184	-------Q-RM--L------
AC.ZM.ZAM716-17	-------Q-RI--L------
ACD.SE.SE8603	---------R---L------
AD.SE.SE6954	-------R-R----------
AD.SE.SE7108	-----R--------------
ADHU.NO.NOGIL3	-------Q-R---L------
ADU.CD.MAL	---------R---L------
AG.NG.G3	---------RM--L------
AG.SE.SE7812	---------R---L------
AGHU.GA.VI354	----------QI---------
AGJ.AU.BFP90	----------M--L------
AGJ.ML.95ML8	---------RM--L------
AGU.CD.Z321	-------Q------------
BF.BR.93BR029.4	-----H---R----------
DF.CD.VI961	---------R----------
U.CD.VI1126	-----R---R---L------
CONSENSUS_CPZ	---------Mm--L------
CPZ.CD.CPZANT	---------MI--L---RS-
CPZ.GA.CPZGAB	-----R-R-MM--L------
CPZ.US.CPZUS	---------MM--L------

Study Subject ID:00RCH37
Study Subject Clone:
Study Subject HLA:A23,A30,B27,B53,Cw2,Cw4
Sequence: Known reactive 20Mer0: RIHIGPGRAFYTTKNIIGTI gp160(308–326)

Possible HLA

A23	A*2301
A30	A*3001,A*3002,A*3003,A*3004
B27	B*27,B*2701,B*2702,B*2703,B*2704,B*2705,B*2706,B*2707,B*2709,B*2710,B*2711,B*2713
B53	B*5301
Cw2	Cw*0202
Cw4	C4,Cw*0401,C*0401,Cw*0402

Possible Epitopes based on anchor residues

(7-15)	GRAFYTTKN	B27
(7-14)	GRAFYTTK	B27
(7-16)	GRAFYTTKNI	B27
(7-16)	GRAFYTTKNI	B*2702

Anchor Residues Searched

B27	X[R]XXXXXXX
B27	X[R]XXXXXX
B27	X[R]XXXXXXXX
B*2702	X[R]XXXXXX[FYILW]
B*2702	X[R]XXXXX[FYILW]
B*2702	X[R]XXXXXXX[FYILW]
B*2705	X[R]XXXXXX[LF]
B*2705	X[R]XXXXX[LF]
B*2705	X[R]XXXXXXX[LF]
B*5301	X[P]XXXXXX[LIVMY]
B*5301	X[P]XXXXX[LIVMY]
B*5301	X[P]XXXXXXX[LIVMY]
Cw*0401	X[YPF]XXXXXX[LF]
Cw*0401	X[YPF]XXXXX[LF]
Cw*0401	X[YPF]XXXXXXX[LF]

Study Subject ID:00RCH37
Study Subject Clone:
Study Subject HLA:A23,A30,B27,B53,Cw2,Cw4
Sequence: Known reactive 20Mer1: ERYLKDQQLLGF gp160(584–595)

Possible HLA

A23	A*2301
A30	A*3001,A*3002,A*3003,A*3004
B27	B*27,B*2701,B*2702,B*2703,B*2704,B*2705,B*2706,B*2707,B*2709,B*2710,B*2711,B*2713
B53	B*5301
Cw2	Cw*0202
Cw4	C4,Cw*0401,C*0401,Cw*0402

Possible Epitopes based on anchor residues

(1-9)	ERYLKDQQL	B27
(1-8)	ERYLKDQQ	B27
(1-10)	ERYLKDQQLL	B27
(1-9)	ERYLKDQQL	B*2702
(1-10)	ERYLKDQQLL	B*2702
(1-9)	ERYLKDQQL	B*2705
(1-10)	ERYLKDQQLL	B*2705
(2-10)	RYLKDQQLL	Cw*0401
(2-9)	RYLKDQQL	Cw*0401

Anchor Residues Searched

B27	X[R]XXXXXXX
B27	X[R]XXXXXX
B27	X[R]XXXXXXXX
B*2702	X[R]XXXXXX[FYILW]
B*2702	X[R]XXXXX[FYILW]
B*2702	X[R]XXXXXXX[FYILW]
B*2705	X[R]XXXXXX[LF]
B*2705	X[R]XXXXX[LF]
B*2705	X[R]XXXXXXX[LF]
B*5301	X[P]XXXXXX[LIVMY]
B*5301	X[P]XXXXX[LIVMY]
B*5301	X[P]XXXXXXX[LIVMY]
Cw*0401	X[YPF]XXXXXX[LF]
Cw*0401	X[YPF]XXXXX[LF]
Cw*0401	X[YPF]XXXXXXX[LF]

Study Subject ID:00RCH37
Study Subject Clone:
Study Subject HLA:A23,A30,B27,B53,Cw2,Cw4
Sequence: Known reactive 20Mer2: EVLKYWWNLLQYWSQELKSS gp160(791–810)

Possible HLA

A23	A*2301
A30	A*3001,A*3002,A*3003,A*3004
B27	B*27,B*2701,B*2702,B*2703,B*2704,B*2705,B*2706,B*2707,B*2709,B*2710,B*2711,B*2713
B53	B*5301
Cw2	Cw*0202
Cw4	C4,Cw*0401,C*0401,Cw*0402

Possible Epitopes based on anchor residues

Anchor Residues Searched

B27	X[R]XXXXXXX
B27	X[R]XXXXXX
B27	X[R]XXXXXXXX
B*2702	X[R]XXXXXX[FYILW]
B*2702	X[R]XXXXX[FYILW]
B*2702	X[R]XXXXXXX[FYILW]
B*2705	X[R]XXXXXX[LF]
B*2705	X[R]XXXXX[LF]
B*2705	X[R]XXXXXXX[LF]
B*5301	X[P]XXXXXX[LIVMY]
B*5301	X[P]XXXXX[LIVMY]
B*5301	X[P]XXXXXXX[LIVMY]
Cw*0401	X[YPF]XXXXXX[LF]
Cw*0401	X[YPF]XXXXX[LF]
Cw*0401	X[YPF]XXXXXXX[LF]

Study Subject ID:00RCH37
Study Subject Clone:
Study Subject HLA:A23,A30,B27,B53,Cw2,Cw4
Sequence: Known reactive 20Mer3: LHIPTRIRQGLERALL gp160(841–856)

Possible HLA

A23	A*2301
A30	A*3001,A*3002,A*3003,A*3004
B27	B*27,B*2701,B*2702,B*2703,B*2704,B*2705,B*2706,B*2707,B*2709,B*2710,B*2711,B*2713
B53	B*5301
Cw2	Cw*0202
Cw4	C4,Cw*0401,C*0401,Cw*0402

Possible Epitopes based on anchor residues

(5-13)	TRIRQGLER	B27
(7-15)	IRQGLERAL	B27
(5-12)	TRIRQGLE	B27
(7-14)	IRQGLERA	B27
(5-14)	TRIRQGLERA	B27
(7-16)	IRQGLERALL	B27
(7-15)	IRQGLERAL	B*2702
(7-16)	IRQGLERALL	B*2702
(7-15)	IRQGLERAL	B*2705
(7-16)	IRQGLERALL	B*2705
(3-11)	IPTRIRQGL	B*5301
(3-11)	IPTRIRQGL	Cw*0401

Anchor Residues Searched

B27	X[R]XXXXXXX
B27	X[R]XXXXXX
B27	X[R]XXXXXXXX
B*2702	X[R]XXXXXX[FYILW]
B*2702	X[R]XXXXX[FYILW]
B*2702	X[R]XXXXXXX[FYILW]
B*2705	X[R]XXXXXX[LF]
B*2705	X[R]XXXXX[LF]
B*2705	X[R]XXXXXXX[LF]
B*5301	X[P]XXXXXX[LIVMY]
B*5301	X[P]XXXXX[LIVMY]
B*5301	X[P]XXXXXXX[LIVMY]
Cw*0401	X[YPF]XXXXXX[LF]

Cw*0401 X[YPF]XXXXX[LF]
Cw*0401 X[YPF]XXXXXXX[LF]

Study Subject ID:00RCH37
Study Subject Clone:
Study Subject HLA:A23,A30,B27,B53,Cw2,Cw4
Sequence: Known reactive 20Mer4: VPVWKEATTTLFCASDAKAY gp160(42–61)

Possible HLA

A23	A*2301
A30	A*3001,A*3002,A*3003,A*3004
B27	B*27,B*2701,B*2702,B*2703,B*2704,B*2705,B*2706,B*2707,B*2709,B*2710,B*2711,B*2713
B53	B*5301
Cw2	Cw*0202
Cw4	C4,Cw*0401,C*0401,Cw*0402

Possible Epitopes based on anchor residues

Anchor Residues Searched

B27	X[R]XXXXXXX
B27	X[R]XXXXXX
B27	X[R]XXXXXXXX
B*2702	X[R]XXXXXX[FYILW]
B*2702	X[R]XXXXX[FYILW]
B*2702	X[R]XXXXXXX[FYILW]
B*2705	X[R]XXXXXX[LF]
B*2705	X[R]XXXXX[LF]
B*2705	X[R]XXXXXXX[LF]
B*5301	X[P]XXXXXX[LIVMY]
B*5301	X[P]XXXXX[LIVMY]
B*5301	X[P]XXXXXXX[LIVMY]
Cw*0401	X[YPF]XXXXXX[LF]
Cw*0401	X[YPF]XXXXX[LF]
Cw*0401	X[YPF]XXXXXXX[LF]

Study Subject ID:00RCH37
Study Subject Clone:
Study Subject HLA:A23,A30,B27,B53,Cw2,Cw4
Sequence: Known reactive 20Mer5: GELDRWEKIRLRPGGKKKYK p17(11–30)

Possible HLA

A23	A*2301
A30	A*3001,A*3002,A*3003,A*3004
B27	B*27,B*2701,B*2702,B*2703,B*2704,B*2705,B*2706,B*2707,B*2709,B*2710,B*2711,B*2713
B53	B*5301
Cw2	Cw*0202
Cw4	C4,Cw*0401,C*0401,Cw*0402

Possible Epitopes based on anchor residues

(4-12)	DRWEKIRLR	B27
(9-17)	IRLRPGGKK	B27
(11-19)	LRPGGKKKY	B27
(4-11)	DRWEKIRL	B27
(9-16)	IRLRPGGK	B27
(11-18)	LRPGGKKK	B27
(4-13)	DRWEKIRLRP	B27
(9-18)	IRLRPGGKKK	B27
(11-20)	LRPGGKKKYK	B27
(11-19)	LRPGGKKKY	B*2702
(4-11)	DRWEKIRL	B*2702
(4-11)	DRWEKIRL	B*2705
(12-19)	RPGGKKKY	B*5301

Anchor Residues Searched

B27	X[R]XXXXXXX
B27	X[R]XXXXXX
B27	X[R]XXXXXXXX
B*2702	X[R]XXXXXX[FYILW]
B*2702	X[R]XXXXX[FYILW]
B*2702	X[R]XXXXXXX[FYILW]
B*2705	X[R]XXXXXX[LF]
B*2705	X[R]XXXXX[LF]
B*2705	X[R]XXXXXXX[LF]
B*5301	X[P]XXXXXX[LIVMY]
B*5301	X[P]XXXXX[LIVMY]
B*5301	X[P]XXXXXXX[LIVMY]

Cw*0401 X[YPF]XXXXXX[LF]
Cw*0401 X[YPF]XXXXX[LF]
Cw*0401 X[YPF]XXXXXXX[LF]

Study Subject ID:00RCH37
Study Subject Clone:
Study Subject HLA:A23,A30,B27,B53,Cw2,Cw4
Sequence: Known reactive 20Mer6: LRPGGKKKYKLKHIVWASRE p17(21–40)

Possible HLA

A23	A*2301
A30	A*3001,A*3002,A*3003,A*3004
B27	B*27,B*2701,B*2702,B*2703,B*2704,B*2705,B*2706,B*2707,B*2709,B*2710,B*2711,B*2713
B53	B*5301
Cw2	Cw*0202
Cw4	C4,Cw*0401,C*0401,Cw*0402

Possible Epitopes based on anchor residues

(1-9)	LRPGGKKKY	B27
(1-8)	LRPGGKKK	B27
(1-10)	LRPGGKKKYK	B27
(1-9)	LRPGGKKKY	B*2702
(2-9)	RPGGKKKY	B*5301
(2-11)	RPGGKKKYKL	B*5301
(2-11)	RPGGKKKYKL	Cw*0401

Anchor Residues Searched

B27	X[R]XXXXXXX
B27	X[R]XXXXXX
B27	X[R]XXXXXXXX
B*2702	X[R]XXXXXX[FYILW]
B*2702	X[R]XXXXX[FYILW]
B*2702	X[R]XXXXXXX[FYILW]
B*2705	X[R]XXXXXX[LF]
B*2705	X[R]XXXXX[LF]
B*2705	X[R]XXXXXXX[LF]
B*5301	X[P]XXXXXX[LIVMY]
B*5301	X[P]XXXXX[LIVMY]
B*5301	X[P]XXXXXXX[LIVMY]
Cw*0401	X[YPF]XXXXXX[LF]
Cw*0401	X[YPF]XXXXX[LF]
Cw*0401	X[YPF]XXXXXXX[LF]

This table lists epitopes that are experimentally observed to be presented by a HLA type carried by the patient, but the de£ned epitope has substitutions relative to the peptides from your reference strains and so might be missed by your reagents: in HXB2 for Gag, Pol; MN for Env; BRU for Nef, relative to most B clade Sequences in the database:

Protein	Epitope in Database	Epitope in Ref. strain	Epitope in Consensus B	HLA	Notes
p24(47–56)	ATPQDLNMML	ATPQDLNTML	ATPQDLNTML	B53	
p24(48–56)	TPYDINQML	TPQDLNTML	TPQDLNTML	B*5301	
p24(48–56)	TPQDLNQML	TPQDLNTML	TPQDLNTML	B53	
p24(48–56)	TPYDINQML	TPQDLNTML	TPQDLNTML	B53	
p24(131–139)	KRWIILG-NK	KRWIILGLNK	KRWIILGLNK	B27	
p24(131–140)	KRWIILLGLNK	KRWIIL-GLNK	KRWIIL-GLNK	B*27	
p24(131–140)	RRWIQLGLQK	KRWIILGLNK	KRWIILGLNK	B*2703	
p24(131–140)	KRWIILGGLNK	KRWIILG-LNK	KRWIILG-LNK	B*2705	
p24(131–140)	RRWIQLGLQK	KRWIILGLNK	KRWIILGLNK	B27	
p24(131–140)	KRWIIMGLNK	KRWIILGLNK	KRWIILGLNK	B27	
p24(131–140)	KRWIIMG-NK	KRWIILGLNK	KRWIILGLNK	B27	
p24(131–140)	KRWIIMGLNK	KRWIILGLNK	KRWIILGLNK	B27	
gp160(314–322)	GRAFVTIGK	GRAFYTTKN	GRAFYTTGE	B27	
gp160(704–712)	IVNRNRQGY	IVNRVRQGY	IVNRVRQGY	A*3002	
gp160(786–794)	GRRGWEALK	GRRGWEVLK	GRRGWEALK	B27	
gp160(786–795)	GRRGWEALKY	GRRGWEVLKY	GRRGWEALKY	B*2705	
gp160(786–795)	GRRGWEALKY	GRRGWEVLKY	GRRGWEALKY	B27	
gp160(794–802)	KYCWNLLQY	KYWWNLLQY	KYWWNLLQY	A*3002	
Nef(73–82)	SVPLRPMTYK	QVPLRPMTYK	QVPLRPMTYK	B35 or C4	

Table 1: **p24**

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
p24(47–56)	p24()	ATPQDLNMML	HIV-1 exposed seronegative	human(B53)	[Kaul (2000)]
	• 11/16 heavily HIV exposed but persistently seronegative sex-workers in Nairobi had HIV-speci£c CD8 gamma-IFN responses in the cervix – systemic CD8+ T cell responses tended to be to the same epitopes but at generally lower levels than cervical CD8+ T cell responses • Low risk individuals did not have such CD8+ cells • CD8+ epitopes T cell DTVLEDINL (3 individuals), SLYNVATL (4 individuals), LSPRTLNAW (3 individuals) and YPLTFGWCF (4 individuals) were most commonly recognized by the HIV-resistant women				
p24(48–56)	Gag(173–181 HIV-2)	TPYDINQML	HIV-2	human(B*5301)	[Brander & Goulder(2001)]
	• C. Brander notes this is a B*5301 epitope				
p24(48–56)	p24()	TPQDLNQML		human(B53)	[Rowland-Jones (1999)]
	• CTL responses in seronegative highly HIV-exposed African female sex workers in Gambia and Nairobi were studied – these women had no delta 32 deletion in CCR5 • In Gambia there is exposure to both HIV-1 and HIV-2, CTL responses to B35 epitopes in exposed, uninfected women are cross-reactive, and the B35 allele seems to be protective • HIV-2 sequence: TPYDINQML, no cross-reactivity, [Gotch (1993)]				
p24(48–56)	Gag(173–181 HIV-2)	TPYDINQML	HIV-2	human(B53)	[Gotch (1993)]
p24(131–139)	p24(263–272)	KRWIILGNK	HIV-1 infection	human(B27)	[Durali (1998)]
	• Cross-clade CTL response was studied by determining the CTL activity in seven patients from Bangui, (6 A subtype, and 1 AG recombinant infections) and one A subtype infection from a person living in France originally from Togo, to different antigens expressed in vaccinia • Pol reactivity: 8/8 had CTL to A subtype, and 7/8 to B subtype, and HIV-2 Pol was not tested • Gag reactivity: 7/8 reacted with A or B subtype gag, 3/8 with HIV-2 Gag • Nef reactivity: 7/8 reacted with A subtype, and 5/8 with B subtype, none with HIV-2 Nef • Env reactivity: 3/8 reacted with A subtype, 1/8 with B subtype, none with HIV-2 Env • One of the patients was shown to react to this epitope: KRWIILGNK				
p24(131–140)	p24(263–272)	KRWIILLGLNK	HIV-1 infection	human(B*27)	[Huang (2000)]
	• The single cell ELISPOT assay was optimized and highly speci£c, and found to work well even after the primary cells had been frozen and thawed • Increases in gamma interferon producing cells were observed in response to anti-retroviral therapy using single cell IFN-gamma-production ELISPOT • In 3/3 HLA A*02, B*27 individuals, the dominant response in gag measured by both gamma IFN production and T cell lysis was to the B27 epitope, KRWIILLGLNK, not the A2 SLYNTVATL epitope				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
p24(131–140)	p24(260–269 HIV-2)	RRWIQLGLQK		human(B*2703)	[Brander & Goulder(2001)]
	• C. Brander notes this is a B*2703 epitope				
p24(131–140)	p24()	KRWIILGGLNK	HIV-1 infection	human(B*2705)	[Wilson (2000)]
	• Three individuals with highly focused HIV-speci£c CTL responses were studied during acute infection using tetramers – high frequencies of HIV-1-speci£c CD8+ T cells were found prior to seroconversion, and there was a close temporal relationship between the number of circulating HIV-speci£c T cells and viral load was also found • All three patients were B*2705, with HLA alleles: A1, A30/31, B*2705, B35; A1, A*0301, B7, B2705; and A*0201, A*0301, B2705, B39 • Tetramers with peptide variants KRWIILGGLNK and KRWIIMGGLNK were used – CTL from most B27 donors recognize both variants, although one of the three subjects recognized only KRWIILGGLNK • ELISPOT was used to test a panel of CTL epitopes that had been de£ned earlier and were appropriate for the HLA haplotypes of the study subjects – 3/3 subjects showed a dominant response to the B*2705 epitope KRWIILGGLNK • The subject with A*0201 had a moderatly strong strong response to SLYNTVATL • Weak responses were observed to A*301-RLRPGGKKK, A*301-QVPLRPMTYK, and B7-TPGPGVRYPL in the subject who was HLA A1, A*0301, B7, B*2705 • No acute response was detected to the following epitopes: A*201-ILKEPVHGV, A*301-KIRLRPGGK, A*301-AIFQSSMTK, A*301-TVYYGVPVWK, B35-EPIVGAETF, B35-HPDIVIYQY, B35-PPIPVGEIY, B35-NSSKVSQNY, B35-VPLRPMTY, B35-DPNPQEVVL			
p24(131–140)	p24(260–269 HIV-2)	RRWIQLGLQK		human(B27)	[Brander & Walker(1996)]
	• HIV-2, HLA-B*2703, S. Rowland-Jones, Pers. Comm.				
p24(131–140)	p24(263–272)	KRWIIMGLNK	HIV-1 infection	human(B27)	[Klenerman (1994)]
	• Naturally occurring variant KRWIILGLNK may act as antagonist				
p24(131–140)	p24(263–272)	KRWIIMGNK	HIV-1 infection	human(B27)	[Nowak (1995)]
	• Longitudinal study of CTL response and immune escape – the form KRWIILGNK was also found, and both forms stimulate CTL				
p24(131–140)	p24(263–272)	KRWIIMGLNK	HIV-1 infection	human(B27)	[Goulder (1997b), Goulder (1997a)]
	• Six HLA-B27 donors studied make a strong response to this epitope • In 4/6 cases, this was the immunodominant or only CTL response • Two of the cases had an epitope switch to the form KKWIIMGLNK during a period of rapid decline to AIDS, following their asymptomatic period • The arginine to lysine switch is in an anchor residue, and results in immune escape due to severely diminished binding to the B27 molecule • [Goulder (1997a)] is a review of immune escape that summarizes this study in the context of CTL escape to £xation				

Table 2: **gp160**

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(314–322)	gp120(314–322)	GRAFVTIGK	no CTL shown	human(B27)	[Jardetzky (1991)]
	• Study of peptide binding to HLA-B27				
gp160(704–712)	gp160(704–712 LAI)	IVNRNRQGY		human(A*3002)	[Brander & Goulder(2001), Goulder (2001)]
	• C. Brander notes this is an A*3002 epitope				
gp160(786–794)	gp41(791–799 LAI)	GRRGWEALK	HIV-1 infection	human(B27)	[McMichael & Walker(1994)]
	• Review of HIV CTL epitopes • Also: J. Liebermann 1992 and pers. comm. J. Liebermann				
gp160(786–795)	gp41(791–800 LAI)	GRRGWEALKY	HIV infection	human(B*2705)	[Brander & Goulder(2001)]
	• C. Brander notes this is a B*2705 epitope				
gp160(786–795)	gp41(791–800 LAI)	GRRGWEALKY	HIV infection	human(B27)	[Lieberman(1998)]
	• Optimal peptide mapped by titration J. Lieberman, Pers. Comm.				
gp160(794–802)	gp160(794–802 LAI)	KYCWNLLQY		human(A*3002)	[Brander & Goulder(2001), Goulder (2001)]
	• C. Brander notes this is an A*3002 epitope				

Table 3: **Nef**

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
Nef(73–82)	Nef(73–82 LAI)	SVPLRPMTYK	HIV-1 infection	human(B35 or C4)	[Buseyne (1993)]
	• Vertical transmission of HIV ranges from 13% to 39% • Primary assays showed cytotoxic activity against at least one HIV protein was detected in 70% of infected children • Epitopes recognized in £ve children were mapped using synthetic peptides and secondary cultures • Patient EM13, who had a CTL response to three epitopes in Nef, was infected via blood transfusion after birth and went from CDC stage P2A to P2E during the study				

Table 4: **All De£ned Epitopes within the 20mer, regardless of HLA type**

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(308–322)	gp160()	RIHIGPGRAFYTTKN	Immunization with HIV Env peptides in Montanide ISA 51	human()	[Pinto (1999)]
	• Peptide P18: Eight HIV+ individuals were vaccinated with peptides containing speci£c T helper, CTL and Ab epitopes in a Phase I trial • Four displayed a 4-fold increase in PCLUS 3-18 MN-speci£c T helper responses • One patient developed a new, sustained P18MN-peptide-speci£c CTL response – the patient‘s HLA haplotype was A2,30; B53,7; Cw2,4, and anti-HLA A2 antibody did not inhibit the response, suggesting it was not A2 • Patients with low baseline Ab levels developed an increase of neutralizing Ab titers • No signi£cant change was observed in plasma HIV viral loads and CD4 cell counts				
gp160(308–322)	gp120()	RIHIGPGRAFYTTKN	HIV-1 infection	chimpanzee()	[Lubeck (1997)]
	• Epitope-speci£c CTL detected in chimpanzees immunized with adenovirus-HIV-1 MN gp160 recombinant • CTL response may account for protection against subsequent HIV-1 SF2 challenge in a chimpanzee lacking neutralizing antibodies				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	HIV exposure	human()	[Pinto (1995)]
	• CTL and T helper cell reactivity in healthcare workers exposed to HIV				
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	HIV exposure	human()	[Pinto (1995)]
	• CTL and T helper cell reactivity in healthcare workers exposed to HIV				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	vaccinia IIIB gp160	human(A11)	[Achour (1994)]
	• One of 3 HLA type restrictions associated with this peptide				
gp160(308–322)	gp120(315–329 BRU)	RIQRGPGRAFVTIGK	HIV-1 infection	human(A2)	[Dadaglio (1991)]
	• De£ned through blocking CTL activity, and Env deletions				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	HIV-1 infection	human(A2)	[Clerici (1991)]
	• Helper and cytotoxic T cells can be stimulated by this peptide (P18)				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	gp160 vaccinia	human(A2, A3)	[Achour (1993)]
	• Two of 3 HLA type restrictions associated with this peptide				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	IIIB peptide	murine(D^d)	[Takahashi (1989a)]
	• R(8) F(10) MHC/peptide interaction				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	IIIB peptide	murine(D^d)	[Sastry (1992)]
• Free peptide injected into the footpad of a mouse could stimulate speci£c CTL					
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	peptide immunization	murine(D^d)	[Ahlers (1997b)]
• PCLUS 3-18MN synthetic peptide vaccine construct contained T1 helper epitope covalently linked to truncated P18 CTL epitope • A substitution in the T1 peptide stimulated an enhanced Th response and class II binding speci£city, which in turn enhanced CTL induction by vaccine • Construct PCLUS 3-18MN is currently in a phase I vaccine clinical trial					
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	MN gp160 vaccinia	murine(D^d)	[Takahashi (1989b)]
• Y(11 MN) exchange with V(11 IIIB) interchanges speci£cities					
gp160(308–322)	gp120(313–327 IIIB MN RF)	SITKGPGRVIYATGQ	RF gp160 vaccinia	murine(D^d)	[Takahashi (1992)]
• Comparison of MN, IIIB, and RF speci£cities, position 11 is critical					
gp160(308–322)	gp120()	RIQRGPGRAFVTIGK	Pr55 gag-env VLPs	murine(H-2^d)	[Deml (1997)]
• Env bound to virus-like particles (VLPs) can elicit a CTL response that is dependent on the amount of Env presented on the VLP					
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	DNA immunization	murine BALB/c(H-2^d)	[Fomsgaard (1998a)]
• Enhanced B and CTL responses to the V3 region occur following epidermal immunization by gene gun with a chimeric DNA vaccine of V3-hepatitis B surface antigen relative to a gp160 plasmid vaccine					
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	peptide vaccine	murine BALB/c(H-2^d)	[Ahlers (1996), Ahlers (1997a)]
• Vaccine constructs containing helper, antibody and CTL peptide epitopes induce strong Th1, CTL and NAb responses against the autologous HIV-1 virus • The peptide CTL response was as cross-reactive as one elicited by a vaccinia construct expressing rgp160 MN • GM-CSF and IL-12 were the two cytokines most effective for inducing and boosting CTLs					
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	V3:Ty-Virus-like particles	murine(H-2^d)	[Layton (1993)]
• V3-Ty-Virus-like particles can induce type-speci£c CTL in mice in the absence of adjuvant					

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	vaccinia IIIB gp160	murine(H-$2^{d,p,u,q}$)	[Shirai (1992), Shirai (1993)]
	• In a murine system multiple class I molecules can present this peptide, called P18, to CTL, including H-2D^d, H-2D^p, H-2D^q, H-2L^q • The MHC class I molecule D^d as well as H-$2^{u,p,q}$, were found to present peptides P18 and HP53 • The V-β usage in T cells showing cross-reaction between these two peptides was conserved for H-$2^{d,u,p}$, but not in H-2^q				
gp160(308–322)	gp120()	RIQRGPGRAFVTIGK	gag-V3 fusion	murine(H-2d)	[Grif£ths (1993)]
	• Gag-V3 fusion protein immunization elicited V3 CTL response in mice				
gp160(308–322)	gp120()	RIQRGPGRAFVTIGK	DNA vaccine pV1J-gp120	murine(H-2d)	[Barouch (1998)]
	• This study showed that a response to an HIV-1 DNA vaccine could be either augmented or suppressed by plasmid Cytokine/Ig administration				
gp160(308–322)	gp160()	RIHIGPGRAFYTTKN	DNA vaccine, MN gp160	murine BALB/c and C57/BL6(H-2d and H-2b)	[Fomsgaard (1998b)]
	• CTL responses to a primary gene gun vaccination were rapid and strong for several methods of vaccinations: i.m., bupivacaine pretreatment, cardiotoxin pretreatment or gene gun – the CTL response was more rapid and consistent than the antibody response				
gp160(308–322)	gp160()	GIHIGPGRAFYAARK	HIV-gp160, an Env CTL epitope (E7), and the mucosal adjuvant LT(R192G)	murine(H-2D^d)	[Morris (2000)]
	• LT(R192G) induces gp160-speci£c serum and mucosal IgG1 and IgG2a, systemic CTL activity and Th1 and Th2 cytokine responses upon internasal immunization				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	Intranasal peptide with cholera toxin as a mucosal adjuvant	murine(H-2D^d)	[Porgador (1997)]
	• IIIB peptide referred to as R15K • Peptide-speci£c CTLs were induced after *in vitro* restimulation with peptide-pulsed targets • R15K was superior at inducing CTL compared to the RGPGRAFVTI, in contrast to the £ndings of Nehete *et al*. • Memory CTL responses were induced				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	Rec vaccinia expressing HIV-1 P18 IIIB in an H1 in¤uenza hemagglutinin (HA) gene cassette	(H-2D^d)	[Chiba (1999)]
	• Vaccine was capable of priming P18IIIB speci£c CTL in BALB/c mice, but could not induce a P18IIIB-speci£c antibody response				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(308–322)	gp120()	RIHIGPGRAFYTTKN	V3 loop peptides	murine(H-2D^{d})	[Casement (1995)]
	• V3 peptides from MN and SC induce murine CTL that are cross-reactive with diverse strains				
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	MN rgp120 with QS-21 adjuvant	murine(H-2D^{d})	[Newman (1997)]
	• MN vaccine induced CTL reactive with MN, IIIB and RF vaccinia-expressed Env, but not this peptide				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	IIIB rgp120 with QS-21 adjuvant	murine(H-2D^{d})	[Newman (1997)]
	• IIIB vaccine induced IIIB type-speci£c CTL to this peptide (P18), and an additional Env CTL response that was cross-reactive				
gp160(308–322)	gp120(315–329)	RIQRGPGRAFVTIGK	vaccinia IIIB gp160	murine(H-2D^{d})	[Takahashi (1988)]
	• V3 loop CTL response in mice vaccinated with gp160				
gp160(308–322)	gp120(315–329)	RIQRGPGRAFVTIGK	18IIIB peptides coated with peptide	murine BALB/c(H-2D^{d})	[Fukasawa (1998)]
	• The peptide RIQRGPGRAFVTIGK was incorporated into liposomes and given as a subcutaneous injection, which induces a MHC class I restricted CTL response in mice • Liposomes coated with oligomannose show no toxicity and can elicit a potent CTL response upon a single subcutaneous infection, while non-coated liposomes do not, suggesting that oligomannose may be a good adjuvant for CTL responses				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	rec vaccinia gp160	murine(H-2D^{d,p,q}, H-2^{u})	[Shirai (1996)]
	• Multiple murine MHC can cross-present this epitope (P18) and HP53, DRVIEVVQGAYRAIR, to speci£c CTL				
gp160(309–317)	gp120(310–318 SF2)	IYIGPGRAF	HIV-1 infection	human(A*2402)	[Ikeda-Moore (1997)]
	• De£ned using reverse immunogenetics – 59 HLA-A*2402 binding peptides were predicted by searching for A*2402 anchors in HIV proteins (Tyr at 2, and Phe, Leu or Ile at the C term) – 53 of the 59 peptides bound A*2402 • This peptide induced CTL in 1/4 HIV-1+ people tested • IYIGPGRAF bound to A*2402 strongly, the epitope can be processed in a vaccinia construct and presented – no speci£c CTL clones were obtained				
gp160(310–323)	gp120(315–328 MN)	HIGPGRAFYTTKNI	vCP205, canary pox vector, MN gp120 + Gag/Pro IIIB, HIV-1 pseudovirion boost	murine(H-2D^{d})	[Arp (1999)]
	• Epitope p97: HIV-1 pseudovirion boost enhanced the CTL to this epitope in immunized BALB/ c mice as measured by CTL lysis and IFN gamma production				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–319)	gp120(312–320 SF2)	IGPGRAFHT	DNA gp120-plasmid immunization	murine(D^d)	[Selby (1997)]
	• Murine CTL response to peptide observed after immunization with DNA plasmid containing HIV-1 (SF2) gp120 gene regulated by bacteriophage T7 promoter • CTL response required coadministration of rec vaccinia virus expressing T7 RNA polymerase or T7 RNA polymerase soluble protein				
gp160(311–319)	gp120()	IGPGRAFHT	gp120(SF2) DNA vaccine, rgp120 protein boost	murine(H-2D^d)	[Barnett (1997)]
	• CTL were induced by vaccine, and restimulated *in vitro* with V3 peptide • DNA vaccine with protein boost stimulated both CTL and antibodies • Strains SF2 (IGPGRAFHT), US4 (IGPGRAFYA), and CM235 (IGPGQVFYR) were tested				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	DNA gp160 plasmid + peptide boost	Macaca fuscata()	[Okuda (1997)]
	• Murine BALB/c (H-2^d) and macaque both showed highest level of CTL vaccine response when a DNA vaccine was boosted with a peptide including four peptide subtypes of the V3 region, HPG-30 and a fragment of the CD4 binding region				
gp160(311–320)	gp120(318–327)	RGPGRAFVTI	HIV-1 infection	human()	[Kmieciak (1998)]
	• Increased CTL response to cells expressing a VV construct ΔV3 mutant compared with a full-length env gene product • This epitope doesn„t have A2 anchors, but has features that confer promiscuous A2 binding, which may relate to the inhibitory effect seen in this paper				
gp160(311–320)	Env()	RGPGRAFVTI	IIIB DNA vaccine with MIP-1alpha expression vector	murine BALB/c()	[Lu (1999)]
	• A MIP-1 alpha expression plasmid increased the CTL response to this DNA vaccine, as well as the T help response, presumably by the MIP-1 alpha interacting with T lymphocytes and macrophages				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	CTL line from HIV-donor	human(A*0201)	[Alexander-Miller (1996)]
	• This immunogenic peptide does not have the known binding motif for A2.1 • The same optimal peptide for this human HLA-A2.1 epitope was observed for a murine H-2 D^d epitope				
gp160(311–320)	gp120(311–320 IIIB)	RGPGRAFVTI	?	human(A*0201)	[Brander & Goulder(2001)]
	• C. Brander notes this is an A*0201 epitope				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	vaccinia IIIB gp160	human(A2)	[Achour (1996)]
	• Individual was immunized with rec vaccinia gp160 IIIB and boosted with puri£ed gp160 • Lysis only occurs with IIIB P18 peptide pulsed onto autologous targets; MN, RF, SIMI P18 peptides fail to stimulate CTL • Restimulating immune cells from gp160 IIIB vaccinees with MN, RF, or SIMI P18 did not enhance the MN, RF, or SIMI speci£c CTL response				
gp160(311–320)	gp160(318–327 SIMI)	MGPKRAFYAT	vaccinia SIMI gp160	human(A2)	[Achour (1996)]
	• Individual was immunized with rec vaccinia gp160 SIMI and boosted with puri£ed recombinant gp160 SIMI • P18 MN and RF peptides were able to stimulate the HIV-speci£c CTL that arose in response to the SIMI vaccination, thus the P18 MN peptide (IGPGRAFYTT) and the P18 RF peptide (KGPGRVIYAT) could cross-react • The P18 IIIB peptide does not cross-react (RGPGRAFVTI in the epitope region) • gp160 SIMI primed immune cells could generate a signi£cantly broader speci£city when stimulated with P18 MN or P18RF peptides, but not P18 IIIB				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	IIIB peptide	murine(D)	[Nehete (1995)]
	• RGPGRAFVTI was de£ned as the optimal peptide for vaccination, out of RIQRGPGRAFVTIGK • This peptide, in a carrier-free form in Freund's adjuvant, could stimulate Env speci£c CTL in BALB/c mice				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	IIIB peptide	murine(D^d)	[Takahashi (1993)]
	• Successful priming with vaccination of peptide pulsed splenic dendritic cells				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	IIIB peptide	murine(D^d)	[Takahashi (1996)]
	• Exposure of CD8+ CTL to free peptide corresponding to the epitope results in strong inhibition of the CTL response to targets presensitized with the same peptide • The authors propose this is due to a "self-veto'', where the CTL is inactivated by a CD8+ cell carrying the appropriate peptide-MHC complex				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	Env(318–327)	RGPGRAFVTI		murine(H-2^d)	[Lopez (2000)]
	• A series of protease and proteasome inhibitors was used to identify elements of the processing pathway of this epitope, called p18, both from within Env and from within a chimeric hepatitis B protein which allows proper processing • Lactacystin, a proteasome inhibitor, partially inhibits endogenous processing of p18 epitope suggesting both a proteasome pathway and an additional pathway can be used • Both TAP dependent and TAP-independent pathways can be used • 1,10-phenanthrolin (metallopeptidases inhibitor) blocks epitope presentation demonstrating metalloproteinase processing in the Tap-dependent pathway • The Tap-independent pathway does not involve processing by metalloproteinases • This epitope is immunodominant in mice, and is presented by multiple human HLA alleles – it as been suggested that the high processing ef£ciency of this epitope might result in poor presentation of co-expressed epitopes			
gp160(311–320)	gp120()	RGPGRAFVTI	Polyepitope encoding DNA in VVA	murine(H-2^d)	[Hanke (1998b), Hanke (1998a)]
	• This murine epitope was incorporated into a vaccine of CTL epitopes expressed together including 20 HIV epitopes recognized by humans from 12 HLA types, one murine HIV epitope and three macaque HIV epitopes, delivered in a vaccinia virus Ankara (VVA) construct • The murine vaccination was more effective at generating CTL when given i.v. rather than i.m.				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	Combination peptide vaccine	murine BALB/c(H-2^d)	[Hamajima (1997)]
	• B cell epitope HGP-30 also serves as a CTL epitope • Vaccine combined HGP-30, V3 loop peptide variants, and CD4 binding site peptide • IL-12 expression plasmid included with the vaccination enhanced the CTL response				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	HIV-1 DNA vaccine (gp160-CMV) with 8 Br-cAMP as adjuvant	murine(H-2^d)	[Arai (2000)]
	• Low-dosage 8 Br-cAMP given in combination with a DNA vaccine to BALB/c mice increased IgG and sIgA levels, and enhanced Th1, Th2 and CTL activity – the adjuvant activity may be mediated by activation of the CMV promotor in the DNA vaccine				
gp160(311–320)	gp120(318–327 IIIB)	RGPGRAFVTI	rec vaccinia-gp160	murine(H-2^d)	[Goletz (1997)]
	• Anthrax lethal toxin can deliver proteins to the cytosol of eukaryotic cells • A fusion protein linking the delivery domain of the anthrax protein to gp120 achieved cellular uptake, and gp120 was processed allowing presentation of this V3 epitope to CTL *in vitro*				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	gp120(318–327 IIIB)	RGPGRAFVTI	vaccinia IIIB gp160	murine(H-$2^{d,p,u}$)	[Shirai (1997)]
	• Three class I MHC, H-$2^{d,p,u}$, that differ in sequence and serology, cross-present this peptide to T cells of each of the other haplotypes • The amino acids R, F, and I are each critical for strong CTL activity with all three MHC molecules				
gp160(311–320)	gp160()	RGPGRAFVTI	Polyepitope encoding DNA expressed in modi£ed virus Ankara (MVA) DNA vectors	murine(H-2^{d17})	[Hanke (1998a)]
	• MVA is an attenuated vaccinia that can not replicate in mammalian cells – strings of CTL epitopes were delivered and expressed in a MVA DNA vector • γ IFN and CTL activity were induced after a single vaccination • An MVA boost enhanced the response				
gp160(311–320)	gp160()	RGPGRAFVTI	Env DNA prime/boost with IL-12	murine(H-2d)	[Gherardi (2000)]
	• Induction of HIV-1 speci£c CD8 gamma IFN secreting cells was enhanced when IL-12 and Env were given together in a prime, followed by a VV expressing Env boost • If IL-12 was also delivered as a boost from the viral vector, impairment of the IL-12 effects was noted, indicating that the vaccination schedule can be a critical parameter for success with DNA and vaccinia vectors used in combination with immunomodulators • The negative effect observed when IL-12 was delivered with the boost involved nitric oxide				
gp160(311–320)	Env()	RGPGRAFVTI	DNA vaccine pCMV160IIIB/REV with IL-15 and IL-2 or IL-12 expression plasmids	murine(H-2d)	[Xin (1999)]
	• Intranasal immunization of BALB/c mice with HIV DNA and IL-15 plasmid induced increased Th1 and CTL responses • Co-administration of IL-15 with IL-12 or IL-2 plasmids did not alter the effect of IL-15 • Both the CTL (peptide pulsed targets) and DTH response (injection of peptide into footpad) to this peptide was monitored • The Ab response to NNTRKSIRIQRGPGRAFVTIGKIGN was monitored, and IL-15 co-administration resulted in a decrease in the IgG1/IgG2a ratio				
gp160(311–320)	Env()	RGPGRAFVTI	HIV-1 peptide p18 in vaccinia (vp18) or Sindbis (SINp18) vector	murine(H-2d)	[Villacres & Bergmann(1999)]
	• HIV-1 epitope p18 was expressed in two different vaccine vectors and the CTL response was compared in BALB/c mice • Class I tetramer staining showed that up to 13% of the CD8+ splenocytes were p18 speci£c in the acute response using vaccinia, only 4% using Sindbis • vp18 had more gamma IFN secreting splenocytes and activated CD4+ and CD8+ T cells • The overall decline in CD8+ T cells in the transition into memory was 2-3 fold for both vectors • Sindbis virus recombinants induced protective memory cytotoxic T cells, although reduced quantitatively, without vaccinia associated in¤amation and replication				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	Env()	IGPGRARYAR	MVA gp160 89.6	murine BALB/c(H-2D)	[Belyakov (1998b)]
	• Recombinant modi£ed vaccinia virus Ankara (MVA), an attenuated vaccina which has lost the ability to replicate in mammalian cells, was used as the live vector for this vaccine study • A single intrarectal mucosal immunization resulted in long lasting mucosal CTL responses and production of proin¤ammatory cytokines in mucosal sites, indicating that MVA was as effective in inducing mucosal CTL as replicating recombinant vaccinia				
gp160(311–320)	Env()	IGPGRARYAR	HIV peptide PCLUS3-18IIIB	murine BALB/c(H-2D)	[Belyakov (1998a)]
	• HIV protection and mucosal CTL response was studied – an HIV peptide immunogen could protect against gp160 expressing vaccinia in a murine intrarectal challenge system in which neutralizing Abs did not play a role, demonstrating mucosal CTL at the site of exposure can be protective				
gp160(311–320)	gp120()	IGPGRAFYTT	*B. abortus*-peptide conjugate	murine(H-2D^d)	[Lapham (1996)]
	• *B. abortus*-peptide conjugate induced a virus-speci£c CTL response in CD4+ lymphocyte depleted mice				
gp160(311–320)	gp160()	RGPGRAFVTI	rec non-replicating adenoviruses (RAd501 (env) and RAd46 (rev) or RAd142 (env+rev))	murine(H-2D^d)	[Bruce (1999)]
	• A good HIV-1 Env immune response using non-replicating adenovirus vectors in BALB/c mice is dependent upon the presence of the stimulatory tat/rev 5‘splice-donor site sequence and the presence of Rev • Administration of monocistronic RAd501 expressing env and RAd46 expressing rev resulted in a positive CTL response, but required two immunizations for a CTL response comparable to that induced by the bicistronic virus RAd142 • Administration of RAd501 alone gave a low CTL response, but no humoral response, suggesting a lower level of antigen may be required to stimulate CTL				
gp160(311–320)	gp120()	IGPGRAFYTT	*B. abortus*-peptide conjugate	murine(H-2D^d)	[Lapham (1996)]
	• *B. abortus*-peptide conjugate induced a virus-speci£c CTL response in CD4+ lymphocyte depleted mice				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	peptide	murine(H-2D^d)	[Takeshita (1995)]
	• XGPXRXXXXI are critical for binding, consistent with H-2D^d motif XGPX(RKH)XXX(X)(LIF)				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	Env()	RGPGRAFTVTI	multi-epitope DNA vaccine	murine(H-2D^d)	[Hanke & McMichael(1999), Hanke (1999)]
	• Vaccinated mice elicited a CTL response to a gene gun-delivered multiepitope vaccine to two epitopes studied that are known to elicit CTL in mice: SYIPSAEKI from Plasmodium berghei and RGPGRAFTVTI from HIV-1 Env • Different vaccination protocols were tested and it was found that a gene gun mediated delivery followed by an MVA boost was as good as i. m. immunization followed by a MVA boost – this is advantageous as gene gun delivery requires far less DNA than i.m. DNA priming • CTL activity was high (60% - 70% speci£c lysis at effector target) when vaccinated with a single gene gun immunization and an MVA boost, and improved with two gene gun vaccinations				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	A rapidly degraded form of Env	murine(L^d)	[Tobery & Siliciano(1997)]
	• An HIV-1 Env vaccine was targeted for rapid cytoplasmic degradation • The rapidly degraded form rapidly stimulated CTL to this peptide, faster than the normal vaccinia-env • The rapidly degraded form also stimulated greater speci£c CTL lysis and higher CTLp frequencies than normal Env • Similar results were obtained for a Nef protein designed for rapid degradation				
gp160(314–322)	gp120(314–322)	GRAFVTIGK	no CTL shown	human(B27)	[Jardetzky (1991)]
	• Study of peptide binding to HLA-B27				

Table 5: **All De£ned Epitopes within the 20mer, regardless of HLA type**

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(308–322)	gp160()	RIHIGPGRAFYTTKN	Immunization with HIV Env peptides in Montanide ISA 51	human()	[Pinto (1999)]
	• Peptide P18: Eight HIV+ individuals were vaccinated with peptides containing speci£c T helper, CTL and Ab epitopes in a Phase I trial • Four displayed a 4-fold increase in PCLUS 3-18 MN-speci£c T helper responses • One patient developed a new, sustained P18MN-peptide-speci£c CTL response – the patient‘s HLA haplotype was A2,30; B53,7; Cw2,4, and anti-HLA A2 antibody did not inhibit the response, suggesting it was not A2 • Patients with low baseline Ab levels developed an increase of neutralizing Ab titers • No signi£cant change was observed in plasma HIV viral loads and CD4 cell counts				
gp160(308–322)	gp120()	RIHIGPGRAFYTTKN	HIV-1 infection	chimpanzee()	[Lubeck (1997)]
	• Epitope-speci£c CTL detected in chimpanzees immunized with adenovirus-HIV-1 MN gp160 recombinant • CTL response may account for protection against subsequent HIV-1 SF2 challenge in a chimpanzee lacking neutralizing antibodies				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	HIV exposure	human()	[Pinto (1995)]
	• CTL and T helper cell reactivity in healthcare workers exposed to HIV				
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	HIV exposure	human()	[Pinto (1995)]
	• CTL and T helper cell reactivity in healthcare workers exposed to HIV				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	vaccinia IIIB gp160	human(A11)	[Achour (1994)]
	• One of 3 HLA type restrictions associated with this peptide				
gp160(308–322)	gp120(315–329 BRU)	RIQRGPGRAFVTIGK	HIV-1 infection	human(A2)	[Dadaglio (1991)]
	• De£ned through blocking CTL activity, and Env deletions				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	HIV-1 infection	human(A2)	[Clerici (1991)]
	• Helper and cytotoxic T cells can be stimulated by this peptide (P18)				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	gp160 vaccinia	human(A2, A3)	[Achour (1993)]
	• Two of 3 HLA type restrictions associated with this peptide				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	IIIB peptide	murine(D^d)	[Takahashi (1989a)]
	• R(8) F(10) MHC/peptide interaction				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	IIIB peptide	murine(D^d)	[Sastry (1992)]
• Free peptide injected into the footpad of a mouse could stimulate speci£c CTL					
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	peptide immunization	murine(D^d)	[Ahlers (1997b)]
• PCLUS 3-18MN synthetic peptide vaccine construct contained T1 helper epitope covalently linked to truncated P18 CTL epitope • A substitution in the T1 peptide stimulated an enhanced Th response and class II binding speci£city, which in turn enhanced CTL induction by vaccine • Construct PCLUS 3-18MN is currently in a phase I vaccine clinical trial					
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	MN gp160 vaccinia	murine(D^d)	[Takahashi (1989b)]
• Y(11 MN) exchange with V(11 IIIB) interchanges speci£cities					
gp160(308–322)	gp120(313–327 IIIB MN RF)	SITKGPGRVIYATGQ	RF gp160 vaccinia	murine(D^d)	[Takahashi (1992)]
• Comparison of MN, IIIB, and RF speci£cities, position 11 is critical					
gp160(308–322)	gp120()	RIQRGPGRAFVTIGK	Pr55 gag-env VLPs	murine(H-2^d)	[Deml (1997)]
• Env bound to virus-like particles (VLPs) can elicit a CTL response that is dependent on the amount of Env presented on the VLP					
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	DNA immunization	murine BALB/c(H-2^d)	[Fomsgaard (1998a)]
• Enhanced B and CTL responses to the V3 region occur following epidermal immunization by gene gun with a chimeric DNA vaccine of V3-hepatitis B surface antigen relative to a gp160 plasmid vaccine					
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	peptide vaccine	murine BALB/c(H-2^d)	[Ahlers (1996), Ahlers (1997a)]
• Vaccine constructs containing helper, antibody and CTL peptide epitopes induce strong Th1, CTL and NAb responses against the autologous HIV-1 virus • The peptide CTL response was as cross-reactive as one elicited by a vaccinia construct expressing rgp160 MN • GM-CSF and IL-12 were the two cytokines most effective for inducing and boosting CTLs					
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	V3:Ty-Virus-like particles	murine(H-2^d)	[Layton (1993)]
• V3-Ty-Virus-like particles can induce type-speci£c CTL in mice in the absence of adjuvant					

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	vaccinia IIIB gp160	murine(H-$2^{d,p,u,q}$)	[Shirai (1992), Shirai (1993)]
	• In a murine system multiple class I molecules can present this peptide, called P18, to CTL, including H-2D^d, H-2D^p, H-2D^q, H-2L^q • The MHC class I molecule D^d as well as H-$2^{u,p,q}$, were found to present peptides P18 and HP53 • The V-β usage in T cells showing cross-reaction between these two peptides was conserved for H-$2^{d,u,p}$, but not in H-2^q				
gp160(308–322)	gp120()	RIQRGPGRAFVTIGK	gag-V3 fusion	murine(H-2d)	[Grif£ths (1993)]
	• Gag-V3 fusion protein immunization elicited V3 CTL response in mice				
gp160(308–322)	gp120()	RIQRGPGRAFVTIGK	DNA vaccine pV1J-gp120	murine(H-2d)	[Barouch (1998)]
	• This study showed that a response to an HIV-1 DNA vaccine could be either augmented or suppressed by plasmid Cytokine/Ig administration				
gp160(308–322)	gp160()	RIHIGPGRAFYTTKN	DNA vaccine, MN gp160	murine BALB/c and C57/BL6(H-2d and H-2b)	[Fomsgaard (1998b)]
	• CTL responses to a primary gene gun vaccination were rapid and strong for several methods of vaccinations: i.m., bupivacaine pretreatment, cardiotoxin pretreatment or gene gun – the CTL response was more rapid and consistent than the antibody response				
gp160(308–322)	gp160()	GIHIGPGRAFYAARK	HIV-gp160, an Env CTL epitope (E7), and the mucosal adjuvant LT(R192G)	murine(H-2D^d)	[Morris (2000)]
	• LT(R192G) induces gp160-speci£c serum and mucosal IgG1 and IgG2a, systemic CTL activity and Th1 and Th2 cytokine responses upon internasal immunization				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	Intranasal peptide with cholera toxin as a mucosal adjuvant	murine(H-2D^d)	[Porgador (1997)]
	• IIIB peptide referred to as R15K • Peptide-speci£c CTLs were induced after *in vitro* restimulation with peptide-pulsed targets • R15K was superior at inducing CTL compared to the RGPGRAFVTI, in contrast to the £ndings of Nehete *et al*. • Memory CTL responses were induced				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	Rec vaccinia expressing HIV-1 P18 IIIB in an H1 in¤uenza hemagglutinin (HA) gene cassette	(H-2D^d)	[Chiba (1999)]
	• Vaccine was capable of priming P18IIIB speci£c CTL in BALB/c mice, but could not induce a P18IIIB-speci£c antibody response				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(308–322)	gp120()	RIHIGPGRAFYTTKN	V3 loop peptides	murine(H-2D^{d})	[Casement (1995)]
	• V3 peptides from MN and SC induce murine CTL that are cross-reactive with diverse strains				
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	MN rgp120 with QS-21 adjuvant	murine(H-2D^{d})	[Newman (1997)]
	• MN vaccine induced CTL reactive with MN, IIIB and RF vaccinia-expressed Env, but not this peptide				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	IIIB rgp120 with QS-21 adjuvant	murine(H-2D^{d})	[Newman (1997)]
	• IIIB vaccine induced IIIB type-speci£c CTL to this peptide (P18), and an additional Env CTL response that was cross-reactive				
gp160(308–322)	gp120(315–329)	RIQRGPGRAFVTIGK	vaccinia IIIB gp160	murine(H-2D^{d})	[Takahashi (1988)]
	• V3 loop CTL response in mice vaccinated with gp160				
gp160(308–322)	gp120(315–329)	RIQRGPGRAFVTIGK	18IIIB peptides coated with peptide	murine BALB/c(H-2D^{d})	[Fukasawa (1998)]
	• The peptide RIQRGPGRAFVTIGK was incorporated into liposomes and given as a subcutaneous injection, which induces a MHC class I restricted CTL response in mice • Liposomes coated with oligomannose show no toxicity and can elicit a potent CTL response upon a single subcutaneous infection, while non-coated liposomes do not, suggesting that oligomannose may be a good adjuvant for CTL responses				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	rec vaccinia gp160	murine(H-2D^{d,p,q}, H-2^{u})	[Shirai (1996)]
	• Multiple murine MHC can cross-present this epitope (P18) and HP53, DRVIEVVQGAYRAIR, to speci£c CTL				
gp160(309–317)	gp120(310–318 SF2)	IYIGPGRAF	HIV-1 infection	human(A*2402)	[Ikeda-Moore (1997)]
	• De£ned using reverse immunogenetics – 59 HLA-A*2402 binding peptides were predicted by searching for A*2402 anchors in HIV proteins (Tyr at 2, and Phe, Leu or Ile at the C term) – 53 of the 59 peptides bound A*2402 • This peptide induced CTL in 1/4 HIV-1+ people tested • IYIGPGRAF bound to A*2402 strongly, the epitope can be processed in a vaccinia construct and presented – no speci£c CTL clones were obtained				
gp160(310–323)	gp120(315–328 MN)	HIGPGRAFYTTKNI	vCP205, canary pox vector, MN gp120 + Gag/Pro IIIB, HIV-1 pseudovirion boost	murine(H-2D^{d})	[Arp (1999)]
	• Epitope p97: HIV-1 pseudovirion boost enhanced the CTL to this epitope in immunized BALB/ c mice as measured by CTL lysis and IFN gamma production				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–319)	gp120(312–320 SF2)	IGPGRAFHT	DNA gp120-plasmid immunization	murine(D^d)	[Selby (1997)]
	• Murine CTL response to peptide observed after immunization with DNA plasmid containing HIV-1 (SF2) gp120 gene regulated by bacteriophage T7 promoter • CTL response required coadministration of rec vaccinia virus expressing T7 RNA polymerase or T7 RNA polymerase soluble protein				
gp160(311–319)	gp120()	IGPGRAFHT	gp120(SF2) DNA vaccine, rgp120 protein boost	murine(H-2D^d)	[Barnett (1997)]
	• CTL were induced by vaccine, and restimulated *in vitro* with V3 peptide • DNA vaccine with protein boost stimulated both CTL and antibodies • Strains SF2 (IGPGRAFHT), US4 (IGPGRAFYA), and CM235 (IGPGQVFYR) were tested				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	DNA gp160 plasmid + peptide boost	Macaca fuscata()	[Okuda (1997)]
	• Murine BALB/c (H-2^d) and macaque both showed highest level of CTL vaccine response when a DNA vaccine was boosted with a peptide including four peptide subtypes of the V3 region, HPG-30 and a fragment of the CD4 binding region				
gp160(311–320)	gp120(318–327)	RGPGRAFVTI	HIV-1 infection	human()	[Kmieciak (1998)]
	• Increased CTL response to cells expressing a VV construct ΔV3 mutant compared with a full-length env gene product • This epitope doesn„t have A2 anchors, but has features that confer promiscuous A2 binding, which may relate to the inhibitory effect seen in this paper				
gp160(311–320)	Env()	RGPGRAFVTI	IIIB DNA vaccine with MIP-1alpha expression vector	murine BALB/c()	[Lu (1999)]
	• A MIP-1 alpha expression plasmid increased the CTL response to this DNA vaccine, as well as the T help response, presumably by the MIP-1 alpha interacting with T lymphocytes and macrophages				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	CTL line from HIV-donor	human(A*0201)	[Alexander-Miller (1996)]
	• This immunogenic peptide does not have the known binding motif for A2.1 • The same optimal peptide for this human HLA-A2.1 epitope was observed for a murine H-2 D^d epitope				
gp160(311–320)	gp120(311–320 IIIB)	RGPGRAFVTI	?	human(A*0201)	[Brander & Goulder(2001)]
	• C. Brander notes this is an A*0201 epitope				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	vaccinia IIIB gp160	human(A2)	[Achour (1996)]
	• Individual was immunized with rec vaccinia gp160 IIIB and boosted with puri£ed gp160 • Lysis only occurs with IIIB P18 peptide pulsed onto autologous targets; MN, RF, SIMI P18 peptides fail to stimulate CTL • Restimulating immune cells from gp160 IIIB vaccinees with MN, RF, or SIMI P18 did not enhance the MN, RF, or SIMI speci£c CTL response				
gp160(311–320)	gp160(318–327 SIMI)	MGPKRAFYAT	vaccinia SIMI gp160	human(A2)	[Achour (1996)]
	• Individual was immunized with rec vaccinia gp160 SIMI and boosted with puri£ed recombinant gp160 SIMI • P18 MN and RF peptides were able to stimulate the HIV-speci£c CTL that arose in response to the SIMI vaccination, thus the P18 MN peptide (IGPGRAFYTT) and the P18 RF peptide (KGPGRVIYAT) could cross-react • The P18 IIIB peptide does not cross-react (RGPGRAFVTI in the epitope region) • gp160 SIMI primed immune cells could generate a signi£cantly broader speci£city when stimulated with P18 MN or P18RF peptides, but not P18 IIIB				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	IIIB peptide	murine(D)	[Nehete (1995)]
	• RGPGRAFVTI was de£ned as the optimal peptide for vaccination, out of RIQRGPGRAFVTIGK • This peptide, in a carrier-free form in Freund's adjuvant, could stimulate Env speci£c CTL in BALB/c mice				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	IIIB peptide	murine(D^d)	[Takahashi (1993)]
	• Successful priming with vaccination of peptide pulsed splenic dendritic cells				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	IIIB peptide	murine(D^d)	[Takahashi (1996)]
	• Exposure of CD8+ CTL to free peptide corresponding to the epitope results in strong inhibition of the CTL response to targets presensitized with the same peptide • The authors propose this is due to a "self-veto'', where the CTL is inactivated by a CD8+ cell carrying the appropriate peptide-MHC complex				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	Env(318–327)	RGPGRAFVTI		murine(H-2^d)	[Lopez (2000)]
	• A series of protease and proteasome inhibitors was used to identify elements of the processing pathway of this epitope, called p18, both from within Env and from within a chimeric hepatitis B protein which allows proper processing • Lactacystin, a proteasome inhibitor, partially inhibits endogenous processing of p18 epitope suggesting both a proteasome pathway and an additional pathway can be used • Both TAP dependent and TAP-independent pathways can be used • 1,10-phenanthrolin (metallopeptidases inhibitor) blocks epitope presentation demonstrating metalloproteinase processing in the Tap-dependent pathway • The Tap-independent pathway does not involve processing by metalloproteinases • This epitope is immunodominant in mice, and is presented by multiple human HLA alleles – it as been suggested that the high processing ef£ciency of this epitope might result in poor presentation of co-expressed epitopes			
gp160(311–320)	gp120()	RGPGRAFVTI	Polyepitope encoding DNA in VVA	murine(H-2^d)	[Hanke (1998b), Hanke (1998a)]
	• This murine epitope was incorporated into a vaccine of CTL epitopes expressed together including 20 HIV epitopes recognized by humans from 12 HLA types, one murine HIV epitope and three macaque HIV epitopes, delivered in a vaccinia virus Ankara (VVA) construct • The murine vaccination was more effective at generating CTL when given i.v. rather than i.m.				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	Combination peptide vaccine	murine BALB/c(H-2^d)	[Hamajima (1997)]
	• B cell epitope HGP-30 also serves as a CTL epitope • Vaccine combined HGP-30, V3 loop peptide variants, and CD4 binding site peptide • IL-12 expression plasmid included with the vaccination enhanced the CTL response				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	HIV-1 DNA vaccine (gp160-CMV) with 8 Br-cAMP as adjuvant	murine(H-2^d)	[Arai (2000)]
	• Low-dosage 8 Br-cAMP given in combination with a DNA vaccine to BALB/c mice increased IgG and sIgA levels, and enhanced Th1, Th2 and CTL activity – the adjuvant activity may be mediated by activation of the CMV promotor in the DNA vaccine				
gp160(311–320)	gp120(318–327 IIIB)	RGPGRAFVTI	rec vaccinia-gp160	murine(H-2^d)	[Goletz (1997)]
	• Anthrax lethal toxin can deliver proteins to the cytosol of eukaryotic cells • A fusion protein linking the delivery domain of the anthrax protein to gp120 achieved cellular uptake, and gp120 was processed allowing presentation of this V3 epitope to CTL *in vitro*				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	gp120(318–327 IIIB)	RGPGRAFVTI	vaccinia IIIB gp160	murine(H-$2^{d,p,u}$)	[Shirai (1997)]
	• Three class I MHC, H-$2^{d,p,u}$, that differ in sequence and serology, cross-present this peptide to T cells of each of the other haplotypes • The amino acids R, F, and I are each critical for strong CTL activity with all three MHC molecules				
gp160(311–320)	gp160()	RGPGRAFVTI	Polyepitope encoding DNA expressed in modi£ed virus Ankara (MVA) DNA vectors	murine(H-2^{d17})	[Hanke (1998a)]
	• MVA is an attenuated vaccinia that can not replicate in mammalian cells – strings of CTL epitopes were delivered and expressed in a MVA DNA vector • γ IFN and CTL activity were induced after a single vaccination • An MVA boost enhanced the response				
gp160(311–320)	gp160()	RGPGRAFVTI	Env DNA prime/boost with IL-12	murine(H-2d)	[Gherardi (2000)]
	• Induction of HIV-1 speci£c CD8 gamma IFN secreting cells was enhanced when IL-12 and Env were given together in a prime, followed by a VV expressing Env boost • If IL-12 was also delivered as a boost from the viral vector, impairment of the IL-12 effects was noted, indicating that the vaccination schedule can be a critical parameter for success with DNA and vaccinia vectors used in combination with immunomodulators • The negative effect observed when IL-12 was delivered with the boost involved nitric oxide				
gp160(311–320)	Env()	RGPGRAFVTI	DNA vaccine pCMV160IIIB/REV with IL-15 and IL-2 or IL-12 expression plasmids	murine(H-2d)	[Xin (1999)]
	• Intranasal immunization of BALB/c mice with HIV DNA and IL-15 plasmid induced increased Th1 and CTL responses • Co-administration of IL-15 with IL-12 or IL-2 plasmids did not alter the effect of IL-15 • Both the CTL (peptide pulsed targets) and DTH response (injection of peptide into footpad) to this peptide was monitored • The Ab response to NNTRKSIRIQRGPGRAFVTIGKIGN was monitored, and IL-15 co-administration resulted in a decrease in the IgG1/IgG2a ratio				
gp160(311–320)	Env()	RGPGRAFVTI	HIV-1 peptide p18 in vaccinia (vp18) or Sindbis (SINp18) vector	murine(H-2d)	[Villacres & Bergmann(1999)]
	• HIV-1 epitope p18 was expressed in two different vaccine vectors and the CTL response was compared in BALB/c mice • Class I tetramer staining showed that up to 13% of the CD8+ splenocytes were p18 speci£c in the acute response using vaccinia, only 4% using Sindbis • vp18 had more gamma IFN secreting splenocytes and activated CD4+ and CD8+ T cells • The overall decline in CD8+ T cells in the transition into memory was 2-3 fold for both vectors • Sindbis virus recombinants induced protective memory cytotoxic T cells, although reduced quantitatively, without vaccinia associated in¤amation and replication				

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gp160(311–320)	Env()	IGPGRARYAR	HIV peptide PCLUS3-18IIIB	murine BALB/c(H-2D)	[Belyakov (1998a)]
	• HIV protection and mucosal CTL response was studied – an HIV peptide immunogen could protect against gp160 expressing vaccinia in a murine intrarectal challenge system in which neutralizing Abs did not play a role, demonstrating mucosal CTL at the site of exposure can be protective				
gp160(311–320)	gp120()	IGPGRAFYTT	*B. abortus*-peptide conjugate	murine(H-2D^d)	[Lapham (1996)]
	• *B. abortus*-peptide conjugate induced a virus-speci£c CTL response in CD4+ lymphocyte depleted mice				
gp160(311–320)	gp160()	RGPGRAFVTI	rec non-replicating adenoviruses (RAd501 (env) and RAd46 (rev) or RAd142 (env+rev))	murine(H-2D^d)	[Bruce (1999)]
	• A good HIV-1 Env immune response using non-replicating adenovirus vectors in BALB/c mice is dependent upon the presence of the stimulatory tat/rev 5‘splice-donor site sequence and the presence of Rev • Administration of monocistronic RAd501 expressing env and RAd46 expressing rev resulted in a positive CTL response, but required two immunizations for a CTL response comparable to that induced by the bicistronic virus RAd142 • Administration of RAd501 alone gave a low CTL response, but no humoral response, suggesting a lower level of antigen may be required to stimulate CTL				
gp160(311–320)	gp120()	IGPGRAFYTT	*B. abortus*-peptide conjugate	murine(H-2D^d)	[Lapham (1996)]
	• *B. abortus*-peptide conjugate induced a virus-speci£c CTL response in CD4+ lymphocyte depleted mice				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	peptide	murine(H-2D^d)	[Takeshita (1995)]
	• XGPXRXXXXI are critical for binding, consistent with H-2D^d motif XGPX(RKH)XXX(X)(LIF)				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	Env()	RGPGRAFTVTI	multi-epitope DNA vaccine	murine(H-2D^d)	[Hanke & McMichael(1999), Hanke (1999)]
	• Vaccinated mice elicited a CTL response to a gene gun-delivered multiepitope vaccine to two epitopes studied that are known to elicit CTL in mice: SYIPSAEKI from Plasmodium berghei and RGPGRAFTVTI from HIV-1 Env • Different vaccination protocols were tested and it was found that a gene gun mediated delivery followed by an MVA boost was as good as i. m. immunization followed by a MVA boost – this is advantageous as gene gun delivery requires far less DNA than i.m. DNA priming • CTL activity was high (60% - 70% speci£c lysis at effector target) when vaccinated with a single gene gun immunization and an MVA boost, and improved with two gene gun vaccinations				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	A rapidly degraded form of Env	murine(L^d)	[Tobery & Siliciano(1997)]
	• An HIV-1 Env vaccine was targeted for rapid cytoplasmic degradation • The rapidly degraded form rapidly stimulated CTL to this peptide, faster than the normal vaccinia-env • The rapidly degraded form also stimulated greater speci£c CTL lysis and higher CTLp frequencies than normal Env • Similar results were obtained for a Nef protein designed for rapid degradation				
gp160(314–322)	gp120(314–322)	GRAFVTIGK	no CTL shown	human(B27)	[Jardetzky (1991)]
	• Study of peptide binding to HLA-B27				

Table 6: **All De£ned Epitopes within the 20mer, regardless of HLA type**

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(308–322)	gp160()	RIHIGPGRAFYTTKN	Immunization with HIV Env peptides in Montanide ISA 51	human()	[Pinto (1999)]
	• Peptide P18: Eight HIV+ individuals were vaccinated with peptides containing speci£c T helper, CTL and Ab epitopes in a Phase I trial • Four displayed a 4-fold increase in PCLUS 3-18 MN-speci£c T helper responses • One patient developed a new, sustained P18MN-peptide-speci£c CTL response – the patient‘s HLA haplotype was A2,30; B53,7; Cw2,4, and anti-HLA A2 antibody did not inhibit the response, suggesting it was not A2 • Patients with low baseline Ab levels developed an increase of neutralizing Ab titers • No signi£cant change was observed in plasma HIV viral loads and CD4 cell counts				
gp160(308–322)	gp120()	RIHIGPGRAFYTTKN	HIV-1 infection	chimpanzee()	[Lubeck (1997)]
	• Epitope-speci£c CTL detected in chimpanzees immunized with adenovirus-HIV-1 MN gp160 recombinant • CTL response may account for protection against subsequent HIV-1 SF2 challenge in a chimpanzee lacking neutralizing antibodies				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	HIV exposure	human()	[Pinto (1995)]
	• CTL and T helper cell reactivity in healthcare workers exposed to HIV				
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	HIV exposure	human()	[Pinto (1995)]
	• CTL and T helper cell reactivity in healthcare workers exposed to HIV				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	vaccinia IIIB gp160	human(A11)	[Achour (1994)]
	• One of 3 HLA type restrictions associated with this peptide				
gp160(308–322)	gp120(315–329 BRU)	RIQRGPGRAFVTIGK	HIV-1 infection	human(A2)	[Dadaglio (1991)]
	• De£ned through blocking CTL activity, and Env deletions				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	HIV-1 infection	human(A2)	[Clerici (1991)]
	• Helper and cytotoxic T cells can be stimulated by this peptide (P18)				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	gp160 vaccinia	human(A2, A3)	[Achour (1993)]
	• Two of 3 HLA type restrictions associated with this peptide				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	IIIB peptide	murine(D^d)	[Takahashi (1989a)]
	• R(8) F(10) MHC/peptide interaction				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	IIIB peptide	murine(D^d)	[Sastry (1992)]
• Free peptide injected into the footpad of a mouse could stimulate speci£c CTL					
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	peptide immunization	murine(D^d)	[Ahlers (1997b)]
• PCLUS 3-18MN synthetic peptide vaccine construct contained T1 helper epitope covalently linked to truncated P18 CTL epitope • A substitution in the T1 peptide stimulated an enhanced Th response and class II binding speci£city, which in turn enhanced CTL induction by vaccine • Construct PCLUS 3-18MN is currently in a phase I vaccine clinical trial					
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	MN gp160 vaccinia	murine(D^d)	[Takahashi (1989b)]
• Y(11 MN) exchange with V(11 IIIB) interchanges speci£cities					
gp160(308–322)	gp120(313–327 IIIB MN RF)	SITKGPGRVIYATGQ	RF gp160 vaccinia	murine(D^d)	[Takahashi (1992)]
• Comparison of MN, IIIB, and RF speci£cities, position 11 is critical					
gp160(308–322)	gp120()	RIQRGPGRAFVTIGK	Pr55 gag-env VLPs	murine(H-2^d)	[Deml (1997)]
• Env bound to virus-like particles (VLPs) can elicit a CTL response that is dependent on the amount of Env presented on the VLP					
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	DNA immunization	murine BALB/c(H-2^d)	[Fomsgaard (1998a)]
• Enhanced B and CTL responses to the V3 region occur following epidermal immunization by gene gun with a chimeric DNA vaccine of V3-hepatitis B surface antigen relative to a gp160 plasmid vaccine					
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	peptide vaccine	murine BALB/c(H-2^d)	[Ahlers (1996), Ahlers (1997a)]
• Vaccine constructs containing helper, antibody and CTL peptide epitopes induce strong Th1, CTL and NAb responses against the autologous HIV-1 virus • The peptide CTL response was as cross-reactive as one elicited by a vaccinia construct expressing rgp160 MN • GM-CSF and IL-12 were the two cytokines most effective for inducing and boosting CTLs					
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	V3:Ty-Virus-like particles	murine(H-2^d)	[Layton (1993)]
• V3-Ty-Virus-like particles can induce type-speci£c CTL in mice in the absence of adjuvant					

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	vaccinia IIIB gp160	murine(H-$2^{d,p,u,q}$)	[Shirai (1992), Shirai (1993)]
	• In a murine system multiple class I molecules can present this peptide, called P18, to CTL, including H-2D^d, H-2D^p, H-2D^q, H-2L^q • The MHC class I molecule D^d as well as H-$2^{u,p,q}$, were found to present peptides P18 and HP53 • The V-β usage in T cells showing cross-reaction between these two peptides was conserved for H-$2^{d,u,p}$, but not in H-2^q				
gp160(308–322)	gp120()	RIQRGPGRAFVTIGK	gag-V3 fusion	murine(H-2d)	[Grif£ths (1993)]
	• Gag-V3 fusion protein immunization elicited V3 CTL response in mice				
gp160(308–322)	gp120()	RIQRGPGRAFVTIGK	DNA vaccine pV1J-gp120	murine(H-2d)	[Barouch (1998)]
	• This study showed that a response to an HIV-1 DNA vaccine could be either augmented or suppressed by plasmid Cytokine/Ig administration				
gp160(308–322)	gp160()	RIHIGPGRAFYTTKN	DNA vaccine, MN gp160	murine BALB/c and C57/BL6(H-2d and H-2b)	[Fomsgaard (1998b)]
	• CTL responses to a primary gene gun vaccination were rapid and strong for several methods of vaccinations: i.m., bupivacaine pretreatment, cardiotoxin pretreatment or gene gun – the CTL response was more rapid and consistent than the antibody response				
gp160(308–322)	gp160()	GIHIGPGRAFYAARK	HIV-gp160, an Env CTL epitope (E7), and the mucosal adjuvant LT(R192G)	murine(H-2D^d)	[Morris (2000)]
	• LT(R192G) induces gp160-speci£c serum and mucosal IgG1 and IgG2a, systemic CTL activity and Th1 and Th2 cytokine responses upon internasal immunization				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	Intranasal peptide with cholera toxin as a mucosal adjuvant	murine(H-2D^d)	[Porgador (1997)]
	• IIIB peptide referred to as R15K • Peptide-speci£c CTLs were induced after *in vitro* restimulation with peptide-pulsed targets • R15K was superior at inducing CTL compared to the RGPGRAFVTI, in contrast to the £ndings of Nehete *et al*. • Memory CTL responses were induced				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	Rec vaccinia expressing HIV-1 P18 IIIB in an H1 in¤uenza hemagglutinin (HA) gene cassette	(H-2D^d)	[Chiba (1999)]
	• Vaccine was capable of priming P18IIIB speci£c CTL in BALB/c mice, but could not induce a P18IIIB-speci£c antibody response				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(308–322)	gp120()	RIHIGPGRAFYTTKN	V3 loop peptides	murine(H-2D^{d})	[Casement (1995)]
	• V3 peptides from MN and SC induce murine CTL that are cross-reactive with diverse strains				
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	MN rgp120 with QS-21 adjuvant	murine(H-2D^{d})	[Newman (1997)]
	• MN vaccine induced CTL reactive with MN, IIIB and RF vaccinia-expressed Env, but not this peptide				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	IIIB rgp120 with QS-21 adjuvant	murine(H-2D^{d})	[Newman (1997)]
	• IIIB vaccine induced IIIB type-speci£c CTL to this peptide (P18), and an additional Env CTL response that was cross-reactive				
gp160(308–322)	gp120(315–329)	RIQRGPGRAFVTIGK	vaccinia IIIB gp160	murine(H-2D^{d})	[Takahashi (1988)]
	• V3 loop CTL response in mice vaccinated with gp160				
gp160(308–322)	gp120(315–329)	RIQRGPGRAFVTIGK	18IIIB peptides coated with peptide	murine BALB/c(H-2D^{d})	[Fukasawa (1998)]
	• The peptide RIQRGPGRAFVTIGK was incorporated into liposomes and given as a subcutaneous injection, which induces a MHC class I restricted CTL response in mice • Liposomes coated with oligomannose show no toxicity and can elicit a potent CTL response upon a single subcutaneous infection, while non-coated liposomes do not, suggesting that oligomannose may be a good adjuvant for CTL responses				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	rec vaccinia gp160	murine(H-2D^{d,p,q}, H-2^{u})	[Shirai (1996)]
	• Multiple murine MHC can cross-present this epitope (P18) and HP53, DRVIEVVQGAYRAIR, to speci£c CTL				
gp160(309–317)	gp120(310–318 SF2)	IYIGPGRAF	HIV-1 infection	human(A*2402)	[Ikeda-Moore (1997)]
	• De£ned using reverse immunogenetics – 59 HLA-A*2402 binding peptides were predicted by searching for A*2402 anchors in HIV proteins (Tyr at 2, and Phe, Leu or Ile at the C term) – 53 of the 59 peptides bound A*2402 • This peptide induced CTL in 1/4 HIV-1+ people tested • IYIGPGRAF bound to A*2402 strongly, the epitope can be processed in a vaccinia construct and presented – no speci£c CTL clones were obtained				
gp160(310–323)	gp120(315–328 MN)	HIGPGRAFYTTKNI	vCP205, canary pox vector, MN gp120 + Gag/Pro IIIB, HIV-1 pseudovirion boost	murine(H-2D^{d})	[Arp (1999)]
	• Epitope p97: HIV-1 pseudovirion boost enhanced the CTL to this epitope in immunized BALB/ c mice as measured by CTL lysis and IFN gamma production				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–319)	gp120(312–320 SF2)	IGPGRAFHT	DNA gp120-plasmid immunization	murine(D^d)	[Selby (1997)]
	• Murine CTL response to peptide observed after immunization with DNA plasmid containing HIV-1 (SF2) gp120 gene regulated by bacteriophage T7 promoter • CTL response required coadministration of rec vaccinia virus expressing T7 RNA polymerase or T7 RNA polymerase soluble protein				
gp160(311–319)	gp120()	IGPGRAFHT	gp120(SF2) DNA vaccine, rgp120 protein boost	murine(H-2D^d)	[Barnett (1997)]
	• CTL were induced by vaccine, and restimulated *in vitro* with V3 peptide • DNA vaccine with protein boost stimulated both CTL and antibodies • Strains SF2 (IGPGRAFHT), US4 (IGPGRAFYA), and CM235 (IGPGQVFYR) were tested				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	DNA gp160 plasmid + peptide boost	Macaca fuscata()	[Okuda (1997)]
	• Murine BALB/c (H-2^d) and macaque both showed highest level of CTL vaccine response when a DNA vaccine was boosted with a peptide including four peptide subtypes of the V3 region, HPG-30 and a fragment of the CD4 binding region				
gp160(311–320)	gp120(318–327)	RGPGRAFVTI	HIV-1 infection	human()	[Kmieciak (1998)]
	• Increased CTL response to cells expressing a VV construct ΔV3 mutant compared with a full-length env gene product • This epitope doesn„t have A2 anchors, but has features that confer promiscuous A2 binding, which may relate to the inhibitory effect seen in this paper				
gp160(311–320)	Env()	RGPGRAFVTI	IIIB DNA vaccine with MIP-1alpha expression vector	murine BALB/c()	[Lu (1999)]
	• A MIP-1 alpha expression plasmid increased the CTL response to this DNA vaccine, as well as the T help response, presumably by the MIP-1 alpha interacting with T lymphocytes and macrophages				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	CTL line from HIV-donor	human(A*0201)	[Alexander-Miller (1996)]
	• This immunogenic peptide does not have the known binding motif for A2.1 • The same optimal peptide for this human HLA-A2.1 epitope was observed for a murine H-2 D^d epitope				
gp160(311–320)	gp120(311–320 IIIB)	RGPGRAFVTI	?	human(A*0201)	[Brander & Goulder(2001)]
	• C. Brander notes this is an A*0201 epitope				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	vaccinia IIIB gp160	human(A2)	[Achour (1996)]
	• Individual was immunized with rec vaccinia gp160 IIIB and boosted with puri£ed gp160 • Lysis only occurs with IIIB P18 peptide pulsed onto autologous targets; MN, RF, SIMI P18 peptides fail to stimulate CTL • Restimulating immune cells from gp160 IIIB vaccinees with MN, RF, or SIMI P18 did not enhance the MN, RF, or SIMI speci£c CTL response				
gp160(311–320)	gp160(318–327 SIMI)	MGPKRAFYAT	vaccinia SIMI gp160	human(A2)	[Achour (1996)]
	• Individual was immunized with rec vaccinia gp160 SIMI and boosted with puri£ed recombinant gp160 SIMI • P18 MN and RF peptides were able to stimulate the HIV-speci£c CTL that arose in response to the SIMI vaccination, thus the P18 MN peptide (IGPGRAFYTT) and the P18 RF peptide (KGPGRVIYAT) could cross-react • The P18 IIIB peptide does not cross-react (RGPGRAFVTI in the epitope region) • gp160 SIMI primed immune cells could generate a signi£cantly broader speci£city when stimulated with P18 MN or P18RF peptides, but not P18 IIIB				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	IIIB peptide	murine(D)	[Nehete (1995)]
	• RGPGRAFVTI was de£ned as the optimal peptide for vaccination, out of RIQRGPGRAFVTIGK • This peptide, in a carrier-free form in Freund's adjuvant, could stimulate Env speci£c CTL in BALB/c mice				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	IIIB peptide	murine(D^d)	[Takahashi (1993)]
	• Successful priming with vaccination of peptide pulsed splenic dendritic cells				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	IIIB peptide	murine(D^d)	[Takahashi (1996)]
	• Exposure of CD8+ CTL to free peptide corresponding to the epitope results in strong inhibition of the CTL response to targets presensitized with the same peptide • The authors propose this is due to a "self-veto'', where the CTL is inactivated by a CD8+ cell carrying the appropriate peptide-MHC complex				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	Env(318–327)	RGPGRAFVTI		murine(H-2^d)	[Lopez (2000)]
	• A series of protease and proteasome inhibitors was used to identify elements of the processing pathway of this epitope, called p18, both from within Env and from within a chimeric hepatitis B protein which allows proper processing • Lactacystin, a proteasome inhibitor, partially inhibits endogenous processing of p18 epitope suggesting both a proteasome pathway and an additional pathway can be used • Both TAP dependent and TAP-independent pathways can be used • 1,10-phenanthrolin (metallopeptidases inhibitor) blocks epitope presentation demonstrating metalloproteinase processing in the Tap-dependent pathway • The Tap-independent pathway does not involve processing by metalloproteinases • This epitope is immunodominant in mice, and is presented by multiple human HLA alleles – it as been suggested that the high processing ef£ciency of this epitope might result in poor presentation of co-expressed epitopes			
gp160(311–320)	gp120()	RGPGRAFVTI	Polyepitope encoding DNA in VVA	murine(H-2^d)	[Hanke (1998b), Hanke (1998a)]
	• This murine epitope was incorporated into a vaccine of CTL epitopes expressed together including 20 HIV epitopes recognized by humans from 12 HLA types, one murine HIV epitope and three macaque HIV epitopes, delivered in a vaccinia virus Ankara (VVA) construct • The murine vaccination was more effective at generating CTL when given i.v. rather than i.m.				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	Combination peptide vaccine	murine BALB/c(H-2^d)	[Hamajima (1997)]
	• B cell epitope HGP-30 also serves as a CTL epitope • Vaccine combined HGP-30, V3 loop peptide variants, and CD4 binding site peptide • IL-12 expression plasmid included with the vaccination enhanced the CTL response				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	HIV-1 DNA vaccine (gp160-CMV) with 8 Br-cAMP as adjuvant	murine(H-2^d)	[Arai (2000)]
	• Low-dosage 8 Br-cAMP given in combination with a DNA vaccine to BALB/c mice increased IgG and sIgA levels, and enhanced Th1, Th2 and CTL activity – the adjuvant activity may be mediated by activation of the CMV promotor in the DNA vaccine				
gp160(311–320)	gp120(318–327 IIIB)	RGPGRAFVTI	rec vaccinia-gp160	murine(H-2^d)	[Goletz (1997)]
	• Anthrax lethal toxin can deliver proteins to the cytosol of eukaryotic cells • A fusion protein linking the delivery domain of the anthrax protein to gp120 achieved cellular uptake, and gp120 was processed allowing presentation of this V3 epitope to CTL *in vitro*				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	gp120(318–327 IIIB)	RGPGRAFVTI	vaccinia IIIB gp160	murine(H-$2^{d,p,u}$)	[Shirai (1997)]
	• Three class I MHC, H-$2^{d,p,u}$, that differ in sequence and serology, cross-present this peptide to T cells of each of the other haplotypes • The amino acids R, F, and I are each critical for strong CTL activity with all three MHC molecules				
gp160(311–320)	gp160()	RGPGRAFVTI	Polyepitope encoding DNA expressed in modi£ed virus Ankara (MVA) DNA vectors	murine(H-2^{d17})	[Hanke (1998a)]
	• MVA is an attenuated vaccinia that can not replicate in mammalian cells – strings of CTL epitopes were delivered and expressed in a MVA DNA vector • γ IFN and CTL activity were induced after a single vaccination • An MVA boost enhanced the response				
gp160(311–320)	gp160()	RGPGRAFVTI	Env DNA prime/boost with IL-12	murine(H-2d)	[Gherardi (2000)]
	• Induction of HIV-1 speci£c CD8 gamma IFN secreting cells was enhanced when IL-12 and Env were given together in a prime, followed by a VV expressing Env boost • If IL-12 was also delivered as a boost from the viral vector, impairment of the IL-12 effects was noted, indicating that the vaccination schedule can be a critical parameter for success with DNA and vaccinia vectors used in combination with immunomodulators • The negative effect observed when IL-12 was delivered with the boost involved nitric oxide				
gp160(311–320)	Env()	RGPGRAFVTI	DNA vaccine pCMV160IIIB/REV with IL-15 and IL-2 or IL-12 expression plasmids	murine(H-2d)	[Xin (1999)]
	• Intranasal immunization of BALB/c mice with HIV DNA and IL-15 plasmid induced increased Th1 and CTL responses • Co-administration of IL-15 with IL-12 or IL-2 plasmids did not alter the effect of IL-15 • Both the CTL (peptide pulsed targets) and DTH response (injection of peptide into footpad) to this peptide was monitored • The Ab response to NNTRKSIRIQRGPGRAFVTIGKIGN was monitored, and IL-15 co-administration resulted in a decrease in the IgG1/IgG2a ratio				
gp160(311–320)	Env()	RGPGRAFVTI	HIV-1 peptide p18 in vaccinia (vp18) or Sindbis (SINp18) vector	murine(H-2d)	[Villacres & Bergmann(1999)]
	• HIV-1 epitope p18 was expressed in two different vaccine vectors and the CTL response was compared in BALB/c mice • Class I tetramer staining showed that up to 13% of the CD8+ splenocytes were p18 speci£c in the acute response using vaccinia, only 4% using Sindbis • vp18 had more gamma IFN secreting splenocytes and activated CD4+ and CD8+ T cells • The overall decline in CD8+ T cells in the transition into memory was 2-3 fold for both vectors • Sindbis virus recombinants induced protective memory cytotoxic T cells, although reduced quantitatively, without vaccinia associated in¤amation and replication				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	Env()	IGPGRARYAR	MVA gp160 89.6	murine BALB/c(H-2D)	[Belyakov (1998b)]
	• Recombinant modi£ed vaccinia virus Ankara (MVA), an attenuated vaccina which has lost the ability to replicate in mammalian cells, was used as the live vector for this vaccine study • A single intrarectal mucosal immunization resulted in long lasting mucosal CTL responses and production of proin¤ammatory cytokines in mucosal sites, indicating that MVA was as effective in inducing mucosal CTL as replicating recombinant vaccinia				
gp160(311–320)	Env()	IGPGRARYAR	HIV peptide PCLUS3-18IIIB	murine BALB/c(H-2D)	[Belyakov (1998a)]
	• HIV protection and mucosal CTL response was studied – an HIV peptide immunogen could protect against gp160 expressing vaccinia in a murine intrarectal challenge system in which neutralizing Abs did not play a role, demonstrating mucosal CTL at the site of exposure can be protective				
gp160(311–320)	gp120()	IGPGRAFYTT	*B. abortus*-peptide conjugate	murine(H-2D^d)	[Lapham (1996)]
	• *B. abortus*-peptide conjugate induced a virus-speci£c CTL response in CD4+ lymphocyte depleted mice				
gp160(311–320)	gp160()	RGPGRAFVTI	rec non-replicating adenoviruses (RAd501 (env) and RAd46 (rev) or RAd142 (env+rev))	murine(H-2D^d)	[Bruce (1999)]
	• A good HIV-1 Env immune response using non-replicating adenovirus vectors in BALB/c mice is dependent upon the presence of the stimulatory tat/rev 5‘splice-donor site sequence and the presence of Rev • Administration of monocistronic RAd501 expressing env and RAd46 expressing rev resulted in a positive CTL response, but required two immunizations for a CTL response comparable to that induced by the bicistronic virus RAd142 • Administration of RAd501 alone gave a low CTL response, but no humoral response, suggesting a lower level of antigen may be required to stimulate CTL				
gp160(311–320)	gp120()	IGPGRAFYTT	*B. abortus*-peptide conjugate	murine(H-2D^d)	[Lapham (1996)]
	• *B. abortus*-peptide conjugate induced a virus-speci£c CTL response in CD4+ lymphocyte depleted mice				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	peptide	murine(H-2D^d)	[Takeshita (1995)]
	• XGPXRXXXXI are critical for binding, consistent with H-2D^d motif XGPX(RKH)XXX(X)(LIF)				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	Env()	RGPGRAFTVTI	multi-epitope DNA vaccine	murine(H-2D^d)	[Hanke & McMichael(1999), Hanke (1999)]
	• Vaccinated mice elicited a CTL response to a gene gun-delivered multiepitope vaccine to two epitopes studied that are known to elicit CTL in mice: SYIPSAEKI from Plasmodium berghei and RGPGRAFTVTI from HIV-1 Env • Different vaccination protocols were tested and it was found that a gene gun mediated delivery followed by an MVA boost was as good as i. m. immunization followed by a MVA boost – this is advantageous as gene gun delivery requires far less DNA than i.m. DNA priming • CTL activity was high (60% - 70% speci£c lysis at effector target) when vaccinated with a single gene gun immunization and an MVA boost, and improved with two gene gun vaccinations				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	A rapidly degraded form of Env	murine(L^d)	[Tobery & Siliciano(1997)]
	• An HIV-1 Env vaccine was targeted for rapid cytoplasmic degradation • The rapidly degraded form rapidly stimulated CTL to this peptide, faster than the normal vaccinia-env • The rapidly degraded form also stimulated greater speci£c CTL lysis and higher CTLp frequencies than normal Env • Similar results were obtained for a Nef protein designed for rapid degradation				
gp160(314–322)	gp120(314–322)	GRAFVTIGK	no CTL shown	human(B27)	[Jardetzky (1991)]
	• Study of peptide binding to HLA-B27				

Table 7: **All De£ned Epitopes within the 20mer, regardless of HLA type**

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(308–322)	gp160()	RIHIGPGRAFYTTKN	Immunization with HIV Env peptides in Montanide ISA 51	human()	[Pinto (1999)]
	• Peptide P18: Eight HIV+ individuals were vaccinated with peptides containing speci£c T helper, CTL and Ab epitopes in a Phase I trial • Four displayed a 4-fold increase in PCLUS 3-18 MN-speci£c T helper responses • One patient developed a new, sustained P18MN-peptide-speci£c CTL response – the patient‘s HLA haplotype was A2,30; B53,7; Cw2,4, and anti-HLA A2 antibody did not inhibit the response, suggesting it was not A2 • Patients with low baseline Ab levels developed an increase of neutralizing Ab titers • No signi£cant change was observed in plasma HIV viral loads and CD4 cell counts				
gp160(308–322)	gp120()	RIHIGPGRAFYTTKN	HIV-1 infection	chimpanzee()	[Lubeck (1997)]
	• Epitope-speci£c CTL detected in chimpanzees immunized with adenovirus-HIV-1 MN gp160 recombinant • CTL response may account for protection against subsequent HIV-1 SF2 challenge in a chimpanzee lacking neutralizing antibodies				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	HIV exposure	human()	[Pinto (1995)]
	• CTL and T helper cell reactivity in healthcare workers exposed to HIV				
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	HIV exposure	human()	[Pinto (1995)]
	• CTL and T helper cell reactivity in healthcare workers exposed to HIV				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	vaccinia IIIB gp160	human(A11)	[Achour (1994)]
	• One of 3 HLA type restrictions associated with this peptide				
gp160(308–322)	gp120(315–329 BRU)	RIQRGPGRAFVTIGK	HIV-1 infection	human(A2)	[Dadaglio (1991)]
	• De£ned through blocking CTL activity, and Env deletions				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	HIV-1 infection	human(A2)	[Clerici (1991)]
	• Helper and cytotoxic T cells can be stimulated by this peptide (P18)				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	gp160 vaccinia	human(A2, A3)	[Achour (1993)]
	• Two of 3 HLA type restrictions associated with this peptide				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	IIIB peptide	murine(D^d)	[Takahashi (1989a)]
	• R(8) F(10) MHC/peptide interaction				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	IIIB peptide	murine(D^d)	[Sastry (1992)]
• Free peptide injected into the footpad of a mouse could stimulate speci£c CTL					
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	peptide immunization	murine(D^d)	[Ahlers (1997b)]
• PCLUS 3-18MN synthetic peptide vaccine construct contained T1 helper epitope covalently linked to truncated P18 CTL epitope • A substitution in the T1 peptide stimulated an enhanced Th response and class II binding speci£city, which in turn enhanced CTL induction by vaccine • Construct PCLUS 3-18MN is currently in a phase I vaccine clinical trial					
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	MN gp160 vaccinia	murine(D^d)	[Takahashi (1989b)]
• Y(11 MN) exchange with V(11 IIIB) interchanges speci£cities					
gp160(308–322)	gp120(313–327 IIIB MN RF)	SITKGPGRVIYATGQ	RF gp160 vaccinia	murine(D^d)	[Takahashi (1992)]
• Comparison of MN, IIIB, and RF speci£cities, position 11 is critical					
gp160(308–322)	gp120()	RIQRGPGRAFVTIGK	Pr55 gag-env VLPs	murine(H-2^d)	[Deml (1997)]
• Env bound to virus-like particles (VLPs) can elicit a CTL response that is dependent on the amount of Env presented on the VLP					
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	DNA immunization	murine BALB/c(H-2^d)	[Fomsgaard (1998a)]
• Enhanced B and CTL responses to the V3 region occur following epidermal immunization by gene gun with a chimeric DNA vaccine of V3-hepatitis B surface antigen relative to a gp160 plasmid vaccine					
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	peptide vaccine	murine BALB/c(H-2^d)	[Ahlers (1996), Ahlers (1997a)]
• Vaccine constructs containing helper, antibody and CTL peptide epitopes induce strong Th1, CTL and NAb responses against the autologous HIV-1 virus • The peptide CTL response was as cross-reactive as one elicited by a vaccinia construct expressing rgp160 MN • GM-CSF and IL-12 were the two cytokines most effective for inducing and boosting CTLs					
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	V3:Ty-Virus-like particles	murine(H-2^d)	[Layton (1993)]
• V3-Ty-Virus-like particles can induce type-speci£c CTL in mice in the absence of adjuvant					

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	vaccinia IIIB gp160	murine(H-$2^{d,p,u,q}$)	[Shirai (1992), Shirai (1993)]
	• In a murine system multiple class I molecules can present this peptide, called P18, to CTL, including H-2D^d, H-2D^p, H-2D^q, H-2L^q • The MHC class I molecule D^d as well as H-$2^{u,p,q}$, were found to present peptides P18 and HP53 • The V-β usage in T cells showing cross-reaction between these two peptides was conserved for H-$2^{d,u,p}$, but not in H-2^q				
gp160(308–322)	gp120()	RIQRGPGRAFVTIGK	gag-V3 fusion	murine(H-2d)	[Grif£ths (1993)]
	• Gag-V3 fusion protein immunization elicited V3 CTL response in mice				
gp160(308–322)	gp120()	RIQRGPGRAFVTIGK	DNA vaccine pV1J-gp120	murine(H-2d)	[Barouch (1998)]
	• This study showed that a response to an HIV-1 DNA vaccine could be either augmented or suppressed by plasmid Cytokine/Ig administration				
gp160(308–322)	gp160()	RIHIGPGRAFYTTKN	DNA vaccine, MN gp160	murine BALB/c and C57/BL6(H-2d and H-2b)	[Fomsgaard (1998b)]
	• CTL responses to a primary gene gun vaccination were rapid and strong for several methods of vaccinations: i.m., bupivacaine pretreatment, cardiotoxin pretreatment or gene gun – the CTL response was more rapid and consistent than the antibody response				
gp160(308–322)	gp160()	GIHIGPGRAFYAARK	HIV-gp160, an Env CTL epitope (E7), and the mucosal adjuvant LT(R192G)	murine(H-2D^d)	[Morris (2000)]
	• LT(R192G) induces gp160-speci£c serum and mucosal IgG1 and IgG2a, systemic CTL activity and Th1 and Th2 cytokine responses upon internasal immunization				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	Intranasal peptide with cholera toxin as a mucosal adjuvant	murine(H-2D^d)	[Porgador (1997)]
	• IIIB peptide referred to as R15K • Peptide-speci£c CTLs were induced after *in vitro* restimulation with peptide-pulsed targets • R15K was superior at inducing CTL compared to the RGPGRAFVTI, in contrast to the £ndings of Nehete *et al*. • Memory CTL responses were induced				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	Rec vaccinia expressing HIV-1 P18 IIIB in an H1 in¤uenza hemagglutinin (HA) gene cassette	(H-2D^d)	[Chiba (1999)]
	• Vaccine was capable of priming P18IIIB speci£c CTL in BALB/c mice, but could not induce a P18IIIB-speci£c antibody response				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(308–322)	gp120()	RIHIGPGRAFYTTKN	V3 loop peptides	murine(H-2D^{d})	[Casement (1995)]
	• V3 peptides from MN and SC induce murine CTL that are cross-reactive with diverse strains				
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	MN rgp120 with QS-21 adjuvant	murine(H-2D^{d})	[Newman (1997)]
	• MN vaccine induced CTL reactive with MN, IIIB and RF vaccinia-expressed Env, but not this peptide				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	IIIB rgp120 with QS-21 adjuvant	murine(H-2D^{d})	[Newman (1997)]
	• IIIB vaccine induced IIIB type-speci£c CTL to this peptide (P18), and an additional Env CTL response that was cross-reactive				
gp160(308–322)	gp120(315–329)	RIQRGPGRAFVTIGK	vaccinia IIIB gp160	murine(H-2D^{d})	[Takahashi (1988)]
	• V3 loop CTL response in mice vaccinated with gp160				
gp160(308–322)	gp120(315–329)	RIQRGPGRAFVTIGK	18IIIB peptides coated with peptide	murine BALB/c(H-2D^{d})	[Fukasawa (1998)]
	• The peptide RIQRGPGRAFVTIGK was incorporated into liposomes and given as a subcutaneous injection, which induces a MHC class I restricted CTL response in mice • Liposomes coated with oligomannose show no toxicity and can elicit a potent CTL response upon a single subcutaneous infection, while non-coated liposomes do not, suggesting that oligomannose may be a good adjuvant for CTL responses				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	rec vaccinia gp160	murine(H-2D^{d,p,q}, H-2^{u})	[Shirai (1996)]
	• Multiple murine MHC can cross-present this epitope (P18) and HP53, DRVIEVVQGAYRAIR, to speci£c CTL				
gp160(309–317)	gp120(310–318 SF2)	IYIGPGRAF	HIV-1 infection	human(A*2402)	[Ikeda-Moore (1997)]
	• De£ned using reverse immunogenetics – 59 HLA-A*2402 binding peptides were predicted by searching for A*2402 anchors in HIV proteins (Tyr at 2, and Phe, Leu or Ile at the C term) – 53 of the 59 peptides bound A*2402 • This peptide induced CTL in 1/4 HIV-1+ people tested • IYIGPGRAF bound to A*2402 strongly, the epitope can be processed in a vaccinia construct and presented – no speci£c CTL clones were obtained				
gp160(310–323)	gp120(315–328 MN)	HIGPGRAFYTTKNI	vCP205, canary pox vector, MN gp120 + Gag/Pro IIIB, HIV-1 pseudovirion boost	murine(H-2D^{d})	[Arp (1999)]
	• Epitope p97: HIV-1 pseudovirion boost enhanced the CTL to this epitope in immunized BALB/ c mice as measured by CTL lysis and IFN gamma production				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–319)	gp120(312–320 SF2)	IGPGRAFHT	DNA gp120-plasmid immunization	murine(D^d)	[Selby (1997)]
	• Murine CTL response to peptide observed after immunization with DNA plasmid containing HIV-1 (SF2) gp120 gene regulated by bacteriophage T7 promoter • CTL response required coadministration of rec vaccinia virus expressing T7 RNA polymerase or T7 RNA polymerase soluble protein				
gp160(311–319)	gp120()	IGPGRAFHT	gp120(SF2) DNA vaccine, rgp120 protein boost	murine(H-2D^d)	[Barnett (1997)]
	• CTL were induced by vaccine, and restimulated *in vitro* with V3 peptide • DNA vaccine with protein boost stimulated both CTL and antibodies • Strains SF2 (IGPGRAFHT), US4 (IGPGRAFYA), and CM235 (IGPGQVFYR) were tested				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	DNA gp160 plasmid + peptide boost	Macaca fuscata()	[Okuda (1997)]
	• Murine BALB/c (H-2^d) and macaque both showed highest level of CTL vaccine response when a DNA vaccine was boosted with a peptide including four peptide subtypes of the V3 region, HPG-30 and a fragment of the CD4 binding region				
gp160(311–320)	gp120(318–327)	RGPGRAFVTI	HIV-1 infection	human()	[Kmieciak (1998)]
	• Increased CTL response to cells expressing a VV construct ΔV3 mutant compared with a full-length env gene product • This epitope doesn„t have A2 anchors, but has features that confer promiscuous A2 binding, which may relate to the inhibitory effect seen in this paper				
gp160(311–320)	Env()	RGPGRAFVTI	IIIB DNA vaccine with MIP-1alpha expression vector	murine BALB/c()	[Lu (1999)]
	• A MIP-1 alpha expression plasmid increased the CTL response to this DNA vaccine, as well as the T help response, presumably by the MIP-1 alpha interacting with T lymphocytes and macrophages				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	CTL line from HIV-donor	human(A*0201)	[Alexander-Miller (1996)]
	• This immunogenic peptide does not have the known binding motif for A2.1 • The same optimal peptide for this human HLA-A2.1 epitope was observed for a murine H-2 D^d epitope				
gp160(311–320)	gp120(311–320 IIIB)	RGPGRAFVTI	?	human(A*0201)	[Brander & Goulder(2001)]
	• C. Brander notes this is an A*0201 epitope				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	vaccinia IIIB gp160	human(A2)	[Achour (1996)]
	• Individual was immunized with rec vaccinia gp160 IIIB and boosted with puri£ed gp160 • Lysis only occurs with IIIB P18 peptide pulsed onto autologous targets; MN, RF, SIMI P18 peptides fail to stimulate CTL • Restimulating immune cells from gp160 IIIB vaccinees with MN, RF, or SIMI P18 did not enhance the MN, RF, or SIMI speci£c CTL response				
gp160(311–320)	gp160(318–327 SIMI)	MGPKRAFYAT	vaccinia SIMI gp160	human(A2)	[Achour (1996)]
	• Individual was immunized with rec vaccinia gp160 SIMI and boosted with puri£ed recombinant gp160 SIMI • P18 MN and RF peptides were able to stimulate the HIV-speci£c CTL that arose in response to the SIMI vaccination, thus the P18 MN peptide (IGPGRAFYTT) and the P18 RF peptide (KGPGRVIYAT) could cross-react • The P18 IIIB peptide does not cross-react (RGPGRAFVTI in the epitope region) • gp160 SIMI primed immune cells could generate a signi£cantly broader speci£city when stimulated with P18 MN or P18RF peptides, but not P18 IIIB				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	IIIB peptide	murine(D)	[Nehete (1995)]
	• RGPGRAFVTI was de£ned as the optimal peptide for vaccination, out of RIQRGPGRAFVTIGK • This peptide, in a carrier-free form in Freund's adjuvant, could stimulate Env speci£c CTL in BALB/c mice				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	IIIB peptide	murine(D^d)	[Takahashi (1993)]
	• Successful priming with vaccination of peptide pulsed splenic dendritic cells				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	IIIB peptide	murine(D^d)	[Takahashi (1996)]
	• Exposure of CD8+ CTL to free peptide corresponding to the epitope results in strong inhibition of the CTL response to targets presensitized with the same peptide • The authors propose this is due to a "self-veto'', where the CTL is inactivated by a CD8+ cell carrying the appropriate peptide-MHC complex				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	Env(318–327)	RGPGRAFVTI		murine(H-2^d)	[Lopez (2000)]
	• A series of protease and proteasome inhibitors was used to identify elements of the processing pathway of this epitope, called p18, both from within Env and from within a chimeric hepatitis B protein which allows proper processing • Lactacystin, a proteasome inhibitor, partially inhibits endogenous processing of p18 epitope suggesting both a proteasome pathway and an additional pathway can be used • Both TAP dependent and TAP-independent pathways can be used • 1,10-phenanthrolin (metallopeptidases inhibitor) blocks epitope presentation demonstrating metalloproteinase processing in the Tap-dependent pathway • The Tap-independent pathway does not involve processing by metalloproteinases • This epitope is immunodominant in mice, and is presented by multiple human HLA alleles – it as been suggested that the high processing ef£ciency of this epitope might result in poor presentation of co-expressed epitopes			
gp160(311–320)	gp120()	RGPGRAFVTI	Polyepitope encoding DNA in VVA	murine(H-2^d)	[Hanke (1998b), Hanke (1998a)]
	• This murine epitope was incorporated into a vaccine of CTL epitopes expressed together including 20 HIV epitopes recognized by humans from 12 HLA types, one murine HIV epitope and three macaque HIV epitopes, delivered in a vaccinia virus Ankara (VVA) construct • The murine vaccination was more effective at generating CTL when given i.v. rather than i.m.				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	Combination peptide vaccine	murine BALB/c(H-2^d)	[Hamajima (1997)]
	• B cell epitope HGP-30 also serves as a CTL epitope • Vaccine combined HGP-30, V3 loop peptide variants, and CD4 binding site peptide • IL-12 expression plasmid included with the vaccination enhanced the CTL response				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	HIV-1 DNA vaccine (gp160-CMV) with 8 Br-cAMP as adjuvant	murine(H-2^d)	[Arai (2000)]
	• Low-dosage 8 Br-cAMP given in combination with a DNA vaccine to BALB/c mice increased IgG and sIgA levels, and enhanced Th1, Th2 and CTL activity – the adjuvant activity may be mediated by activation of the CMV promotor in the DNA vaccine				
gp160(311–320)	gp120(318–327 IIIB)	RGPGRAFVTI	rec vaccinia-gp160	murine(H-2^d)	[Goletz (1997)]
	• Anthrax lethal toxin can deliver proteins to the cytosol of eukaryotic cells • A fusion protein linking the delivery domain of the anthrax protein to gp120 achieved cellular uptake, and gp120 was processed allowing presentation of this V3 epitope to CTL *in vitro*				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	gp120(318–327 IIIB)	RGPGRAFVTI	vaccinia IIIB gp160	murine(H-$2^{d,p,u}$)	[Shirai (1997)]
	• Three class I MHC, H-$2^{d,p,u}$, that differ in sequence and serology, cross-present this peptide to T cells of each of the other haplotypes • The amino acids R, F, and I are each critical for strong CTL activity with all three MHC molecules				
gp160(311–320)	gp160()	RGPGRAFVTI	Polyepitope encoding DNA expressed in modi£ed virus Ankara (MVA) DNA vectors	murine(H-2^{d17})	[Hanke (1998a)]
	• MVA is an attenuated vaccinia that can not replicate in mammalian cells – strings of CTL epitopes were delivered and expressed in a MVA DNA vector • γ IFN and CTL activity were induced after a single vaccination • An MVA boost enhanced the response				
gp160(311–320)	gp160()	RGPGRAFVTI	Env DNA prime/boost with IL-12	murine(H-2d)	[Gherardi (2000)]
	• Induction of HIV-1 speci£c CD8 gamma IFN secreting cells was enhanced when IL-12 and Env were given together in a prime, followed by a VV expressing Env boost • If IL-12 was also delivered as a boost from the viral vector, impairment of the IL-12 effects was noted, indicating that the vaccination schedule can be a critical parameter for success with DNA and vaccinia vectors used in combination with immunomodulators • The negative effect observed when IL-12 was delivered with the boost involved nitric oxide				
gp160(311–320)	Env()	RGPGRAFVTI	DNA vaccine pCMV160IIIB/REV with IL-15 and IL-2 or IL-12 expression plasmids	murine(H-2d)	[Xin (1999)]
	• Intranasal immunization of BALB/c mice with HIV DNA and IL-15 plasmid induced increased Th1 and CTL responses • Co-administration of IL-15 with IL-12 or IL-2 plasmids did not alter the effect of IL-15 • Both the CTL (peptide pulsed targets) and DTH response (injection of peptide into footpad) to this peptide was monitored • The Ab response to NNTRKSIRIQRGPGRAFVTIGKIGN was monitored, and IL-15 co-administration resulted in a decrease in the IgG1/IgG2a ratio				
gp160(311–320)	Env()	RGPGRAFVTI	HIV-1 peptide p18 in vaccinia (vp18) or Sindbis (SINp18) vector	murine(H-2d)	[Villacres & Bergmann(1999)]
	• HIV-1 epitope p18 was expressed in two different vaccine vectors and the CTL response was compared in BALB/c mice • Class I tetramer staining showed that up to 13% of the CD8+ splenocytes were p18 speci£c in the acute response using vaccinia, only 4% using Sindbis • vp18 had more gamma IFN secreting splenocytes and activated CD4+ and CD8+ T cells • The overall decline in CD8+ T cells in the transition into memory was 2-3 fold for both vectors • Sindbis virus recombinants induced protective memory cytotoxic T cells, although reduced quantitatively, without vaccinia associated in¤amation and replication				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	Env()	IGPGRARYAR	MVA gp160 89.6	murine BALB/c(H-2D)	[Belyakov (1998b)]
	• Recombinant modi£ed vaccinia virus Ankara (MVA), an attenuated vaccina which has lost the ability to replicate in mammalian cells, was used as the live vector for this vaccine study • A single intrarectal mucosal immunization resulted in long lasting mucosal CTL responses and production of proin¤ammatory cytokines in mucosal sites, indicating that MVA was as effective in inducing mucosal CTL as replicating recombinant vaccinia				
gp160(311–320)	Env()	IGPGRARYAR	HIV peptide PCLUS3-18IIIB	murine BALB/c(H-2D)	[Belyakov (1998a)]
	• HIV protection and mucosal CTL response was studied – an HIV peptide immunogen could protect against gp160 expressing vaccinia in a murine intrarectal challenge system in which neutralizing Abs did not play a role, demonstrating mucosal CTL at the site of exposure can be protective				
gp160(311–320)	gp120()	IGPGRAFYTT	*B. abortus*-peptide conjugate	murine(H-2D^d)	[Lapham (1996)]
	• *B. abortus*-peptide conjugate induced a virus-speci£c CTL response in CD4+ lymphocyte depleted mice				
gp160(311–320)	gp160()	RGPGRAFVTI	rec non-replicating adenoviruses (RAd501 (env) and RAd46 (rev) or RAd142 (env+rev))	murine(H-2D^d)	[Bruce (1999)]
	• A good HIV-1 Env immune response using non-replicating adenovirus vectors in BALB/c mice is dependent upon the presence of the stimulatory tat/rev 5‘splice-donor site sequence and the presence of Rev • Administration of monocistronic RAd501 expressing env and RAd46 expressing rev resulted in a positive CTL response, but required two immunizations for a CTL response comparable to that induced by the bicistronic virus RAd142 • Administration of RAd501 alone gave a low CTL response, but no humoral response, suggesting a lower level of antigen may be required to stimulate CTL				
gp160(311–320)	gp120()	IGPGRAFYTT	*B. abortus*-peptide conjugate	murine(H-2D^d)	[Lapham (1996)]
	• *B. abortus*-peptide conjugate induced a virus-speci£c CTL response in CD4+ lymphocyte depleted mice				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	peptide	murine(H-2D^d)	[Takeshita (1995)]
	• XGPXRXXXXI are critical for binding, consistent with H-2D^d motif XGPX(RKH)XXX(X)(LIF)				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	Env()	RGPGRAFTVTI	multi-epitope DNA vaccine	murine(H-2D^d)	[Hanke & McMichael(1999), Hanke (1999)]
	• Vaccinated mice elicited a CTL response to a gene gun-delivered multiepitope vaccine to two epitopes studied that are known to elicit CTL in mice: SYIPSAEKI from Plasmodium berghei and RGPGRAFTVTI from HIV-1 Env • Different vaccination protocols were tested and it was found that a gene gun mediated delivery followed by an MVA boost was as good as i. m. immunization followed by a MVA boost – this is advantageous as gene gun delivery requires far less DNA than i.m. DNA priming • CTL activity was high (60% - 70% speci£c lysis at effector target) when vaccinated with a single gene gun immunization and an MVA boost, and improved with two gene gun vaccinations				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	A rapidly degraded form of Env	murine(L^d)	[Tobery & Siliciano(1997)]
	• An HIV-1 Env vaccine was targeted for rapid cytoplasmic degradation • The rapidly degraded form rapidly stimulated CTL to this peptide, faster than the normal vaccinia-env • The rapidly degraded form also stimulated greater speci£c CTL lysis and higher CTLp frequencies than normal Env • Similar results were obtained for a Nef protein designed for rapid degradation				
gp160(314–322)	gp120(314–322)	GRAFVTIGK	no CTL shown	human(B27)	[Jardetzky (1991)]
	• Study of peptide binding to HLA-B27				

Table 8: **All De£ned Epitopes within the 20mer, regardless of HLA type**

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(308–322)	gp160()	RIHIGPGRAFYTTKN	Immunization with HIV Env peptides in Montanide ISA 51	human()	[Pinto (1999)]
	• Peptide P18: Eight HIV+ individuals were vaccinated with peptides containing speci£c T helper, CTL and Ab epitopes in a Phase I trial • Four displayed a 4-fold increase in PCLUS 3-18 MN-speci£c T helper responses • One patient developed a new, sustained P18MN-peptide-speci£c CTL response – the patient‘s HLA haplotype was A2,30; B53,7; Cw2,4, and anti-HLA A2 antibody did not inhibit the response, suggesting it was not A2 • Patients with low baseline Ab levels developed an increase of neutralizing Ab titers • No signi£cant change was observed in plasma HIV viral loads and CD4 cell counts				
gp160(308–322)	gp120()	RIHIGPGRAFYTTKN	HIV-1 infection	chimpanzee()	[Lubeck (1997)]
	• Epitope-speci£c CTL detected in chimpanzees immunized with adenovirus-HIV-1 MN gp160 recombinant • CTL response may account for protection against subsequent HIV-1 SF2 challenge in a chimpanzee lacking neutralizing antibodies				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	HIV exposure	human()	[Pinto (1995)]
	• CTL and T helper cell reactivity in healthcare workers exposed to HIV				
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	HIV exposure	human()	[Pinto (1995)]
	• CTL and T helper cell reactivity in healthcare workers exposed to HIV				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	vaccinia IIIB gp160	human(A11)	[Achour (1994)]
	• One of 3 HLA type restrictions associated with this peptide				
gp160(308–322)	gp120(315–329 BRU)	RIQRGPGRAFVTIGK	HIV-1 infection	human(A2)	[Dadaglio (1991)]
	• De£ned through blocking CTL activity, and Env deletions				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	HIV-1 infection	human(A2)	[Clerici (1991)]
	• Helper and cytotoxic T cells can be stimulated by this peptide (P18)				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	gp160 vaccinia	human(A2, A3)	[Achour (1993)]
	• Two of 3 HLA type restrictions associated with this peptide				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	IIIB peptide	murine(D^d)	[Takahashi (1989a)]
	• R(8) F(10) MHC/peptide interaction				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	IIIB peptide	murine(D^d)	[Sastry (1992)]
• Free peptide injected into the footpad of a mouse could stimulate speci£c CTL					
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	peptide immunization	murine(D^d)	[Ahlers (1997b)]
• PCLUS 3-18MN synthetic peptide vaccine construct contained T1 helper epitope covalently linked to truncated P18 CTL epitope • A substitution in the T1 peptide stimulated an enhanced Th response and class II binding speci£city, which in turn enhanced CTL induction by vaccine • Construct PCLUS 3-18MN is currently in a phase I vaccine clinical trial					
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	MN gp160 vaccinia	murine(D^d)	[Takahashi (1989b)]
• Y(11 MN) exchange with V(11 IIIB) interchanges speci£cities					
gp160(308–322)	gp120(313–327 IIIB MN RF)	SITKGPGRVIYATGQ	RF gp160 vaccinia	murine(D^d)	[Takahashi (1992)]
• Comparison of MN, IIIB, and RF speci£cities, position 11 is critical					
gp160(308–322)	gp120()	RIQRGPGRAFVTIGK	Pr55 gag-env VLPs	murine(H-2^d)	[Deml (1997)]
• Env bound to virus-like particles (VLPs) can elicit a CTL response that is dependent on the amount of Env presented on the VLP					
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	DNA immunization	murine BALB/c(H-2^d)	[Fomsgaard (1998a)]
• Enhanced B and CTL responses to the V3 region occur following epidermal immunization by gene gun with a chimeric DNA vaccine of V3-hepatitis B surface antigen relative to a gp160 plasmid vaccine					
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	peptide vaccine	murine BALB/c(H-2^d)	[Ahlers (1996), Ahlers (1997a)]
• Vaccine constructs containing helper, antibody and CTL peptide epitopes induce strong Th1, CTL and NAb responses against the autologous HIV-1 virus • The peptide CTL response was as cross-reactive as one elicited by a vaccinia construct expressing rgp160 MN • GM-CSF and IL-12 were the two cytokines most effective for inducing and boosting CTLs					
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	V3:Ty-Virus-like particles	murine(H-2^d)	[Layton (1993)]
• V3-Ty-Virus-like particles can induce type-speci£c CTL in mice in the absence of adjuvant					

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	vaccinia IIIB gp160	murine(H-$2^{d,p,u,q}$)	[Shirai (1992), Shirai (1993)]
	• In a murine system multiple class I molecules can present this peptide, called P18, to CTL, including H-2D^d, H-2D^p, H-2D^q, H-2L^q • The MHC class I molecule D^d as well as H-$2^{u,p,q}$, were found to present peptides P18 and HP53 • The V-β usage in T cells showing cross-reaction between these two peptides was conserved for H-$2^{d,u,p}$, but not in H-2^q				
gp160(308–322)	gp120()	RIQRGPGRAFVTIGK	gag-V3 fusion	murine(H-2d)	[Grif£ths (1993)]
	• Gag-V3 fusion protein immunization elicited V3 CTL response in mice				
gp160(308–322)	gp120()	RIQRGPGRAFVTIGK	DNA vaccine pV1J-gp120	murine(H-2d)	[Barouch (1998)]
	• This study showed that a response to an HIV-1 DNA vaccine could be either augmented or suppressed by plasmid Cytokine/Ig administration				
gp160(308–322)	gp160()	RIHIGPGRAFYTTKN	DNA vaccine, MN gp160	murine BALB/c and C57/BL6(H-2d and H-2b)	[Fomsgaard (1998b)]
	• CTL responses to a primary gene gun vaccination were rapid and strong for several methods of vaccinations: i.m., bupivacaine pretreatment, cardiotoxin pretreatment or gene gun – the CTL response was more rapid and consistent than the antibody response				
gp160(308–322)	gp160()	GIHIGPGRAFYAARK	HIV-gp160, an Env CTL epitope (E7), and the mucosal adjuvant LT(R192G)	murine(H-2D^d)	[Morris (2000)]
	• LT(R192G) induces gp160-speci£c serum and mucosal IgG1 and IgG2a, systemic CTL activity and Th1 and Th2 cytokine responses upon internasal immunization				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	Intranasal peptide with cholera toxin as a mucosal adjuvant	murine(H-2D^d)	[Porgador (1997)]
	• IIIB peptide referred to as R15K • Peptide-speci£c CTLs were induced after *in vitro* restimulation with peptide-pulsed targets • R15K was superior at inducing CTL compared to the RGPGRAFVTI, in contrast to the £ndings of Nehete *et al.* • Memory CTL responses were induced				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	Rec vaccinia expressing HIV-1 P18 IIIB in an H1 in¤uenza hemagglutinin (HA) gene cassette	(H-2D^d)	[Chiba (1999)]
	• Vaccine was capable of priming P18IIIB speci£c CTL in BALB/c mice, but could not induce a P18IIIB-speci£c antibody response				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(308–322)	gp120()	RIHIGPGRAFYTTKN	V3 loop peptides	murine(H-2D^{d})	[Casement (1995)]
	• V3 peptides from MN and SC induce murine CTL that are cross-reactive with diverse strains				
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	MN rgp120 with QS-21 adjuvant	murine(H-2D^{d})	[Newman (1997)]
	• MN vaccine induced CTL reactive with MN, IIIB and RF vaccinia-expressed Env, but not this peptide				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	IIIB rgp120 with QS-21 adjuvant	murine(H-2D^{d})	[Newman (1997)]
	• IIIB vaccine induced IIIB type-speci£c CTL to this peptide (P18), and an additional Env CTL response that was cross-reactive				
gp160(308–322)	gp120(315–329)	RIQRGPGRAFVTIGK	vaccinia IIIB gp160	murine(H-2D^{d})	[Takahashi (1988)]
	• V3 loop CTL response in mice vaccinated with gp160				
gp160(308–322)	gp120(315–329)	RIQRGPGRAFVTIGK	18IIIB peptides coated with peptide	murine BALB/c(H-2D^{d})	[Fukasawa (1998)]
	• The peptide RIQRGPGRAFVTIGK was incorporated into liposomes and given as a subcutaneous injection, which induces a MHC class I restricted CTL response in mice • Liposomes coated with oligomannose show no toxicity and can elicit a potent CTL response upon a single subcutaneous infection, while non-coated liposomes do not, suggesting that oligomannose may be a good adjuvant for CTL responses				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	rec vaccinia gp160	murine(H-2D^{d,p,q}, H-2^{u})	[Shirai (1996)]
	• Multiple murine MHC can cross-present this epitope (P18) and HP53, DRVIEVVQGAYRAIR, to speci£c CTL				
gp160(309–317)	gp120(310–318 SF2)	IYIGPGRAF	HIV-1 infection	human(A*2402)	[Ikeda-Moore (1997)]
	• De£ned using reverse immunogenetics – 59 HLA-A*2402 binding peptides were predicted by searching for A*2402 anchors in HIV proteins (Tyr at 2, and Phe, Leu or Ile at the C term) – 53 of the 59 peptides bound A*2402 • This peptide induced CTL in 1/4 HIV-1+ people tested • IYIGPGRAF bound to A*2402 strongly, the epitope can be processed in a vaccinia construct and presented – no speci£c CTL clones were obtained				
gp160(310–323)	gp120(315–328 MN)	HIGPGRAFYTTKNI	vCP205, canary pox vector, MN gp120 + Gag/Pro IIIB, HIV-1 pseudovirion boost	murine(H-2D^{d})	[Arp (1999)]
	• Epitope p97: HIV-1 pseudovirion boost enhanced the CTL to this epitope in immunized BALB/ c mice as measured by CTL lysis and IFN gamma production				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–319)	gp120(312–320 SF2)	IGPGRAFHT	DNA gp120-plasmid immunization	murine(D^d)	[Selby (1997)]
	• Murine CTL response to peptide observed after immunization with DNA plasmid containing HIV-1 (SF2) gp120 gene regulated by bacteriophage T7 promoter • CTL response required coadministration of rec vaccinia virus expressing T7 RNA polymerase or T7 RNA polymerase soluble protein				
gp160(311–319)	gp120()	IGPGRAFHT	gp120(SF2) DNA vaccine, rgp120 protein boost	murine(H-2D^d)	[Barnett (1997)]
	• CTL were induced by vaccine, and restimulated *in vitro* with V3 peptide • DNA vaccine with protein boost stimulated both CTL and antibodies • Strains SF2 (IGPGRAFHT), US4 (IGPGRAFYA), and CM235 (IGPGQVFYR) were tested				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	DNA gp160 plasmid + peptide boost	Macaca fuscata()	[Okuda (1997)]
	• Murine BALB/c (H-2^d) and macaque both showed highest level of CTL vaccine response when a DNA vaccine was boosted with a peptide including four peptide subtypes of the V3 region, HPG-30 and a fragment of the CD4 binding region				
gp160(311–320)	gp120(318–327)	RGPGRAFVTI	HIV-1 infection	human()	[Kmieciak (1998)]
	• Increased CTL response to cells expressing a VV construct ΔV3 mutant compared with a full-length env gene product • This epitope doesn„t have A2 anchors, but has features that confer promiscuous A2 binding, which may relate to the inhibitory effect seen in this paper				
gp160(311–320)	Env()	RGPGRAFVTI	IIIB DNA vaccine with MIP-1alpha expression vector	murine BALB/c()	[Lu (1999)]
	• A MIP-1 alpha expression plasmid increased the CTL response to this DNA vaccine, as well as the T help response, presumably by the MIP-1 alpha interacting with T lymphocytes and macrophages				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	CTL line from HIV-donor	human(A*0201)	[Alexander-Miller (1996)]
	• This immunogenic peptide does not have the known binding motif for A2.1 • The same optimal peptide for this human HLA-A2.1 epitope was observed for a murine H-2 D^d epitope				
gp160(311–320)	gp120(311–320 IIIB)	RGPGRAFVTI	?	human(A*0201)	[Brander & Goulder(2001)]
	• C. Brander notes this is an A*0201 epitope				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	vaccinia IIIB gp160	human(A2)	[Achour (1996)]
	• Individual was immunized with rec vaccinia gp160 IIIB and boosted with puri£ed gp160 • Lysis only occurs with IIIB P18 peptide pulsed onto autologous targets; MN, RF, SIMI P18 peptides fail to stimulate CTL • Restimulating immune cells from gp160 IIIB vaccinees with MN, RF, or SIMI P18 did not enhance the MN, RF, or SIMI speci£c CTL response				
gp160(311–320)	gp160(318–327 SIMI)	MGPKRAFYAT	vaccinia SIMI gp160	human(A2)	[Achour (1996)]
	• Individual was immunized with rec vaccinia gp160 SIMI and boosted with puri£ed recombinant gp160 SIMI • P18 MN and RF peptides were able to stimulate the HIV-speci£c CTL that arose in response to the SIMI vaccination, thus the P18 MN peptide (IGPGRAFYTT) and the P18 RF peptide (KGPGRVIYAT) could cross-react • The P18 IIIB peptide does not cross-react (RGPGRAFVTI in the epitope region) • gp160 SIMI primed immune cells could generate a signi£cantly broader speci£city when stimulated with P18 MN or P18RF peptides, but not P18 IIIB				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	IIIB peptide	murine(D)	[Nehete (1995)]
	• RGPGRAFVTI was de£ned as the optimal peptide for vaccination, out of RIQRGPGRAFVTIGK • This peptide, in a carrier-free form in Freund's adjuvant, could stimulate Env speci£c CTL in BALB/c mice				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	IIIB peptide	murine(D^d)	[Takahashi (1993)]
	• Successful priming with vaccination of peptide pulsed splenic dendritic cells				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	IIIB peptide	murine(D^d)	[Takahashi (1996)]
	• Exposure of CD8+ CTL to free peptide corresponding to the epitope results in strong inhibition of the CTL response to targets presensitized with the same peptide • The authors propose this is due to a "self-veto'', where the CTL is inactivated by a CD8+ cell carrying the appropriate peptide-MHC complex				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	Env(318–327)	RGPGRAFVTI		murine(H-2^d)	[Lopez (2000)]
	• A series of protease and proteasome inhibitors was used to identify elements of the processing pathway of this epitope, called p18, both from within Env and from within a chimeric hepatitis B protein which allows proper processing • Lactacystin, a proteasome inhibitor, partially inhibits endogenous processing of p18 epitope suggesting both a proteasome pathway and an additional pathway can be used • Both TAP dependent and TAP-independent pathways can be used • 1,10-phenanthrolin (metallopeptidases inhibitor) blocks epitope presentation demonstrating metalloproteinase processing in the Tap-dependent pathway • The Tap-independent pathway does not involve processing by metalloproteinases • This epitope is immunodominant in mice, and is presented by multiple human HLA alleles – it as been suggested that the high processing ef£ciency of this epitope might result in poor presentation of co-expressed epitopes			
gp160(311–320)	gp120()	RGPGRAFVTI	Polyepitope encoding DNA in VVA	murine(H-2^d)	[Hanke (1998b), Hanke (1998a)]
	• This murine epitope was incorporated into a vaccine of CTL epitopes expressed together including 20 HIV epitopes recognized by humans from 12 HLA types, one murine HIV epitope and three macaque HIV epitopes, delivered in a vaccinia virus Ankara (VVA) construct • The murine vaccination was more effective at generating CTL when given i.v. rather than i.m.				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	Combination peptide vaccine	murine BALB/c(H-2^d)	[Hamajima (1997)]
	• B cell epitope HGP-30 also serves as a CTL epitope • Vaccine combined HGP-30, V3 loop peptide variants, and CD4 binding site peptide • IL-12 expression plasmid included with the vaccination enhanced the CTL response				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	HIV-1 DNA vaccine (gp160-CMV) with 8 Br-cAMP as adjuvant	murine(H-2^d)	[Arai (2000)]
	• Low-dosage 8 Br-cAMP given in combination with a DNA vaccine to BALB/c mice increased IgG and sIgA levels, and enhanced Th1, Th2 and CTL activity – the adjuvant activity may be mediated by activation of the CMV promotor in the DNA vaccine				
gp160(311–320)	gp120(318–327 IIIB)	RGPGRAFVTI	rec vaccinia-gp160	murine(H-2^d)	[Goletz (1997)]
	• Anthrax lethal toxin can deliver proteins to the cytosol of eukaryotic cells • A fusion protein linking the delivery domain of the anthrax protein to gp120 achieved cellular uptake, and gp120 was processed allowing presentation of this V3 epitope to CTL *in vitro*				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	gp120(318–327 IIIB)	RGPGRAFVTI	vaccinia IIIB gp160	murine(H-$2^{d,p,u}$)	[Shirai (1997)]
	• Three class I MHC, H-$2^{d,p,u}$, that differ in sequence and serology, cross-present this peptide to T cells of each of the other haplotypes • The amino acids R, F, and I are each critical for strong CTL activity with all three MHC molecules				
gp160(311–320)	gp160()	RGPGRAFVTI	Polyepitope encoding DNA expressed in modi£ed virus Ankara (MVA) DNA vectors	murine(H-2^{d17})	[Hanke (1998a)]
	• MVA is an attenuated vaccinia that can not replicate in mammalian cells – strings of CTL epitopes were delivered and expressed in a MVA DNA vector • γ IFN and CTL activity were induced after a single vaccination • An MVA boost enhanced the response				
gp160(311–320)	gp160()	RGPGRAFVTI	Env DNA prime/boost with IL-12	murine(H-2d)	[Gherardi (2000)]
	• Induction of HIV-1 speci£c CD8 gamma IFN secreting cells was enhanced when IL-12 and Env were given together in a prime, followed by a VV expressing Env boost • If IL-12 was also delivered as a boost from the viral vector, impairment of the IL-12 effects was noted, indicating that the vaccination schedule can be a critical parameter for success with DNA and vaccinia vectors used in combination with immunomodulators • The negative effect observed when IL-12 was delivered with the boost involved nitric oxide				
gp160(311–320)	Env()	RGPGRAFVTI	DNA vaccine pCMV160IIIB/REV with IL-15 and IL-2 or IL-12 expression plasmids	murine(H-2d)	[Xin (1999)]
	• Intranasal immunization of BALB/c mice with HIV DNA and IL-15 plasmid induced increased Th1 and CTL responses • Co-administration of IL-15 with IL-12 or IL-2 plasmids did not alter the effect of IL-15 • Both the CTL (peptide pulsed targets) and DTH response (injection of peptide into footpad) to this peptide was monitored • The Ab response to NNTRKSIRIQRGPGRAFVTIGKIGN was monitored, and IL-15 co-administration resulted in a decrease in the IgG1/IgG2a ratio				
gp160(311–320)	Env()	RGPGRAFVTI	HIV-1 peptide p18 in vaccinia (vp18) or Sindbis (SINp18) vector	murine(H-2d)	[Villacres & Bergmann(1999)]
	• HIV-1 epitope p18 was expressed in two different vaccine vectors and the CTL response was compared in BALB/c mice • Class I tetramer staining showed that up to 13% of the CD8+ splenocytes were p18 speci£c in the acute response using vaccinia, only 4% using Sindbis • vp18 had more gamma IFN secreting splenocytes and activated CD4+ and CD8+ T cells • The overall decline in CD8+ T cells in the transition into memory was 2-3 fold for both vectors • Sindbis virus recombinants induced protective memory cytotoxic T cells, although reduced quantitatively, without vaccinia associated in¤amation and replication				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	Env()	IGPGRARYAR	MVA gp160 89.6	murine BALB/c(H-2D)	[Belyakov (1998b)]
	• Recombinant modi£ed vaccinia virus Ankara (MVA), an attenuated vaccina which has lost the ability to replicate in mammalian cells, was used as the live vector for this vaccine study • A single intrarectal mucosal immunization resulted in long lasting mucosal CTL responses and production of proin¤ammatory cytokines in mucosal sites, indicating that MVA was as effective in inducing mucosal CTL as replicating recombinant vaccinia				
gp160(311–320)	Env()	IGPGRARYAR	HIV peptide PCLUS3-18IIIB	murine BALB/c(H-2D)	[Belyakov (1998a)]
	• HIV protection and mucosal CTL response was studied – an HIV peptide immunogen could protect against gp160 expressing vaccinia in a murine intrarectal challenge system in which neutralizing Abs did not play a role, demonstrating mucosal CTL at the site of exposure can be protective				
gp160(311–320)	gp120()	IGPGRAFYTT	*B. abortus*-peptide conjugate	murine(H-2D^d)	[Lapham (1996)]
	• *B. abortus*-peptide conjugate induced a virus-speci£c CTL response in CD4+ lymphocyte depleted mice				
gp160(311–320)	gp160()	RGPGRAFVTI	rec non-replicating adenoviruses (RAd501 (env) and RAd46 (rev) or RAd142 (env+rev))	murine(H-2D^d)	[Bruce (1999)]
	• A good HIV-1 Env immune response using non-replicating adenovirus vectors in BALB/c mice is dependent upon the presence of the stimulatory tat/rev 5‘splice-donor site sequence and the presence of Rev • Administration of monocistronic RAd501 expressing env and RAd46 expressing rev resulted in a positive CTL response, but required two immunizations for a CTL response comparable to that induced by the bicistronic virus RAd142 • Administration of RAd501 alone gave a low CTL response, but no humoral response, suggesting a lower level of antigen may be required to stimulate CTL				
gp160(311–320)	gp120()	IGPGRAFYTT	*B. abortus*-peptide conjugate	murine(H-2D^d)	[Lapham (1996)]
	• *B. abortus*-peptide conjugate induced a virus-speci£c CTL response in CD4+ lymphocyte depleted mice				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	peptide	murine(H-2D^d)	[Takeshita (1995)]
	• XGPXRXXXXI are critical for binding, consistent with H-2D^d motif XGPX(RKH)XXX(X)(LIF)				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	Env()	RGPGRAFTVTI	multi-epitope DNA vaccine	murine(H-2D^d)	[Hanke & McMichael(1999), Hanke (1999)]
	• Vaccinated mice elicited a CTL response to a gene gun-delivered multiepitope vaccine to two epitopes studied that are known to elicit CTL in mice: SYIPSAEKI from Plasmodium berghei and RGPGRAFTVTI from HIV-1 Env • Different vaccination protocols were tested and it was found that a gene gun mediated delivery followed by an MVA boost was as good as i. m. immunization followed by a MVA boost – this is advantageous as gene gun delivery requires far less DNA than i.m. DNA priming • CTL activity was high (60% - 70% speci£c lysis at effector target) when vaccinated with a single gene gun immunization and an MVA boost, and improved with two gene gun vaccinations				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	A rapidly degraded form of Env	murine(L^d)	[Tobery & Siliciano(1997)]
	• An HIV-1 Env vaccine was targeted for rapid cytoplasmic degradation • The rapidly degraded form rapidly stimulated CTL to this peptide, faster than the normal vaccinia-env • The rapidly degraded form also stimulated greater speci£c CTL lysis and higher CTLp frequencies than normal Env • Similar results were obtained for a Nef protein designed for rapid degradation				
gp160(314–322)	gp120(314–322)	GRAFVTIGK	no CTL shown	human(B27)	[Jardetzky (1991)]
	• Study of peptide binding to HLA-B27				

Table 9: **All De£ned Epitopes within the 20mer, regardless of HLA type**

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(308–322)	gp160()	RIHIGPGRAFYTTKN	Immunization with HIV Env peptides in Montanide ISA 51	human()	[Pinto (1999)]
	• Peptide P18: Eight HIV+ individuals were vaccinated with peptides containing speci£c T helper, CTL and Ab epitopes in a Phase I trial • Four displayed a 4-fold increase in PCLUS 3-18 MN-speci£c T helper responses • One patient developed a new, sustained P18MN-peptide-speci£c CTL response – the patient‘s HLA haplotype was A2,30; B53,7; Cw2,4, and anti-HLA A2 antibody did not inhibit the response, suggesting it was not A2 • Patients with low baseline Ab levels developed an increase of neutralizing Ab titers • No signi£cant change was observed in plasma HIV viral loads and CD4 cell counts				
gp160(308–322)	gp120()	RIHIGPGRAFYTTKN	HIV-1 infection	chimpanzee()	[Lubeck (1997)]
	• Epitope-speci£c CTL detected in chimpanzees immunized with adenovirus-HIV-1 MN gp160 recombinant • CTL response may account for protection against subsequent HIV-1 SF2 challenge in a chimpanzee lacking neutralizing antibodies				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	HIV exposure	human()	[Pinto (1995)]
	• CTL and T helper cell reactivity in healthcare workers exposed to HIV				
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	HIV exposure	human()	[Pinto (1995)]
	• CTL and T helper cell reactivity in healthcare workers exposed to HIV				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	vaccinia IIIB gp160	human(A11)	[Achour (1994)]
	• One of 3 HLA type restrictions associated with this peptide				
gp160(308–322)	gp120(315–329 BRU)	RIQRGPGRAFVTIGK	HIV-1 infection	human(A2)	[Dadaglio (1991)]
	• De£ned through blocking CTL activity, and Env deletions				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	HIV-1 infection	human(A2)	[Clerici (1991)]
	• Helper and cytotoxic T cells can be stimulated by this peptide (P18)				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	gp160 vaccinia	human(A2, A3)	[Achour (1993)]
	• Two of 3 HLA type restrictions associated with this peptide				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	IIIB peptide	murine(D^d)	[Takahashi (1989a)]
	• R(8) F(10) MHC/peptide interaction				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	IIIB peptide	murine(D^d)	[Sastry (1992)]
• Free peptide injected into the footpad of a mouse could stimulate speci£c CTL					
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	peptide immunization	murine(D^d)	[Ahlers (1997b)]
• PCLUS 3-18MN synthetic peptide vaccine construct contained T1 helper epitope covalently linked to truncated P18 CTL epitope • A substitution in the T1 peptide stimulated an enhanced Th response and class II binding speci£city, which in turn enhanced CTL induction by vaccine • Construct PCLUS 3-18MN is currently in a phase I vaccine clinical trial					
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	MN gp160 vaccinia	murine(D^d)	[Takahashi (1989b)]
• Y(11 MN) exchange with V(11 IIIB) interchanges speci£cities					
gp160(308–322)	gp120(313–327 IIIB MN RF)	SITKGPGRVIYATGQ	RF gp160 vaccinia	murine(D^d)	[Takahashi (1992)]
• Comparison of MN, IIIB, and RF speci£cities, position 11 is critical					
gp160(308–322)	gp120()	RIQRGPGRAFVTIGK	Pr55 gag-env VLPs	murine(H-2^d)	[Deml (1997)]
• Env bound to virus-like particles (VLPs) can elicit a CTL response that is dependent on the amount of Env presented on the VLP					
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	DNA immunization	murine BALB/c(H-2^d)	[Fomsgaard (1998a)]
• Enhanced B and CTL responses to the V3 region occur following epidermal immunization by gene gun with a chimeric DNA vaccine of V3-hepatitis B surface antigen relative to a gp160 plasmid vaccine					
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	peptide vaccine	murine BALB/c(H-2^d)	[Ahlers (1996), Ahlers (1997a)]
• Vaccine constructs containing helper, antibody and CTL peptide epitopes induce strong Th1, CTL and NAb responses against the autologous HIV-1 virus • The peptide CTL response was as cross-reactive as one elicited by a vaccinia construct expressing rgp160 MN • GM-CSF and IL-12 were the two cytokines most effective for inducing and boosting CTLs					
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	V3:Ty-Virus-like particles	murine(H-2^d)	[Layton (1993)]
• V3-Ty-Virus-like particles can induce type-speci£c CTL in mice in the absence of adjuvant					

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	vaccinia IIIB gp160	murine(H-$2^{d,p,u,q}$)	[Shirai (1992), Shirai (1993)]
	• In a murine system multiple class I molecules can present this peptide, called P18, to CTL, including H-2D^d, H-2D^p, H-2D^q, H-2L^q • The MHC class I molecule D^d as well as H-$2^{u,p,q}$, were found to present peptides P18 and HP53 • The V-β usage in T cells showing cross-reaction between these two peptides was conserved for H-$2^{d,u,p}$, but not in H-2^q				
gp160(308–322)	gp120()	RIQRGPGRAFVTIGK	gag-V3 fusion	murine(H-2d)	[Grif£ths (1993)]
	• Gag-V3 fusion protein immunization elicited V3 CTL response in mice				
gp160(308–322)	gp120()	RIQRGPGRAFVTIGK	DNA vaccine pV1J-gp120	murine(H-2d)	[Barouch (1998)]
	• This study showed that a response to an HIV-1 DNA vaccine could be either augmented or suppressed by plasmid Cytokine/Ig administration				
gp160(308–322)	gp160()	RIHIGPGRAFYTTKN	DNA vaccine, MN gp160	murine BALB/c and C57/BL6(H-2d and H-2b)	[Fomsgaard (1998b)]
	• CTL responses to a primary gene gun vaccination were rapid and strong for several methods of vaccinations: i.m., bupivacaine pretreatment, cardiotoxin pretreatment or gene gun – the CTL response was more rapid and consistent than the antibody response				
gp160(308–322)	gp160()	GIHIGPGRAFYAARK	HIV-gp160, an Env CTL epitope (E7), and the mucosal adjuvant LT(R192G)	murine(H-2D^d)	[Morris (2000)]
	• LT(R192G) induces gp160-speci£c serum and mucosal IgG1 and IgG2a, systemic CTL activity and Th1 and Th2 cytokine responses upon internasal immunization				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	Intranasal peptide with cholera toxin as a mucosal adjuvant	murine(H-2D^d)	[Porgador (1997)]
	• IIIB peptide referred to as R15K • Peptide-speci£c CTLs were induced after *in vitro* restimulation with peptide-pulsed targets • R15K was superior at inducing CTL compared to the RGPGRAFVTI, in contrast to the £ndings of Nehete *et al*. • Memory CTL responses were induced				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	Rec vaccinia expressing HIV-1 P18 IIIB in an H1 in¤uenza hemagglutinin (HA) gene cassette	(H-2D^d)	[Chiba (1999)]
	• Vaccine was capable of priming P18IIIB speci£c CTL in BALB/c mice, but could not induce a P18IIIB-speci£c antibody response				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(308–322)	gp120()	RIHIGPGRAFYTTKN	V3 loop peptides	murine(H-2D^{d})	[Casement (1995)]
	• V3 peptides from MN and SC induce murine CTL that are cross-reactive with diverse strains				
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	MN rgp120 with QS-21 adjuvant	murine(H-2D^{d})	[Newman (1997)]
	• MN vaccine induced CTL reactive with MN, IIIB and RF vaccinia-expressed Env, but not this peptide				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	IIIB rgp120 with QS-21 adjuvant	murine(H-2D^{d})	[Newman (1997)]
	• IIIB vaccine induced IIIB type-speci£c CTL to this peptide (P18), and an additional Env CTL response that was cross-reactive				
gp160(308–322)	gp120(315–329)	RIQRGPGRAFVTIGK	vaccinia IIIB gp160	murine(H-2D^{d})	[Takahashi (1988)]
	• V3 loop CTL response in mice vaccinated with gp160				
gp160(308–322)	gp120(315–329)	RIQRGPGRAFVTIGK	18IIIB peptides coated with peptide	murine BALB/c(H-2D^{d})	[Fukasawa (1998)]
	• The peptide RIQRGPGRAFVTIGK was incorporated into liposomes and given as a subcutaneous injection, which induces a MHC class I restricted CTL response in mice • Liposomes coated with oligomannose show no toxicity and can elicit a potent CTL response upon a single subcutaneous infection, while non-coated liposomes do not, suggesting that oligomannose may be a good adjuvant for CTL responses				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	rec vaccinia gp160	murine(H-2D^{d,p,q}, H-2^{u})	[Shirai (1996)]
	• Multiple murine MHC can cross-present this epitope (P18) and HP53, DRVIEVVQGAYRAIR, to speci£c CTL				
gp160(309–317)	gp120(310–318 SF2)	IYIGPGRAF	HIV-1 infection	human(A*2402)	[Ikeda-Moore (1997)]
	• De£ned using reverse immunogenetics – 59 HLA-A*2402 binding peptides were predicted by searching for A*2402 anchors in HIV proteins (Tyr at 2, and Phe, Leu or Ile at the C term) – 53 of the 59 peptides bound A*2402 • This peptide induced CTL in 1/4 HIV-1+ people tested • IYIGPGRAF bound to A*2402 strongly, the epitope can be processed in a vaccinia construct and presented – no speci£c CTL clones were obtained				
gp160(310–323)	gp120(315–328 MN)	HIGPGRAFYTTKNI	vCP205, canary pox vector, MN gp120 + Gag/Pro IIIB, HIV-1 pseudovirion boost	murine(H-2D^{d})	[Arp (1999)]
	• Epitope p97: HIV-1 pseudovirion boost enhanced the CTL to this epitope in immunized BALB/ c mice as measured by CTL lysis and IFN gamma production				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–319)	gp120(312–320 SF2)	IGPGRAFHT	DNA gp120-plasmid immunization	murine(D^d)	[Selby (1997)]
	• Murine CTL response to peptide observed after immunization with DNA plasmid containing HIV-1 (SF2) gp120 gene regulated by bacteriophage T7 promoter • CTL response required coadministration of rec vaccinia virus expressing T7 RNA polymerase or T7 RNA polymerase soluble protein				
gp160(311–319)	gp120()	IGPGRAFHT	gp120(SF2) DNA vaccine, rgp120 protein boost	murine(H-2D^d)	[Barnett (1997)]
	• CTL were induced by vaccine, and restimulated *in vitro* with V3 peptide • DNA vaccine with protein boost stimulated both CTL and antibodies • Strains SF2 (IGPGRAFHT), US4 (IGPGRAFYA), and CM235 (IGPGQVFYR) were tested				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	DNA gp160 plasmid + peptide boost	Macaca fuscata()	[Okuda (1997)]
	• Murine BALB/c (H-2^d) and macaque both showed highest level of CTL vaccine response when a DNA vaccine was boosted with a peptide including four peptide subtypes of the V3 region, HPG-30 and a fragment of the CD4 binding region				
gp160(311–320)	gp120(318–327)	RGPGRAFVTI	HIV-1 infection	human()	[Kmieciak (1998)]
	• Increased CTL response to cells expressing a VV construct ΔV3 mutant compared with a full-length env gene product • This epitope doesn„t have A2 anchors, but has features that confer promiscuous A2 binding, which may relate to the inhibitory effect seen in this paper				
gp160(311–320)	Env()	RGPGRAFVTI	IIIB DNA vaccine with MIP-1alpha expression vector	murine BALB/c()	[Lu (1999)]
	• A MIP-1 alpha expression plasmid increased the CTL response to this DNA vaccine, as well as the T help response, presumably by the MIP-1 alpha interacting with T lymphocytes and macrophages				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	CTL line from HIV-donor	human(A*0201)	[Alexander-Miller (1996)]
	• This immunogenic peptide does not have the known binding motif for A2.1 • The same optimal peptide for this human HLA-A2.1 epitope was observed for a murine H-2 D^d epitope				
gp160(311–320)	gp120(311–320 IIIB)	RGPGRAFVTI	?	human(A*0201)	[Brander & Goulder(2001)]
	• C. Brander notes this is an A*0201 epitope				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	vaccinia IIIB gp160	human(A2)	[Achour (1996)]
	• Individual was immunized with rec vaccinia gp160 IIIB and boosted with puri£ed gp160 • Lysis only occurs with IIIB P18 peptide pulsed onto autologous targets; MN, RF, SIMI P18 peptides fail to stimulate CTL • Restimulating immune cells from gp160 IIIB vaccinees with MN, RF, or SIMI P18 did not enhance the MN, RF, or SIMI speci£c CTL response				
gp160(311–320)	gp160(318–327 SIMI)	MGPKRAFYAT	vaccinia SIMI gp160	human(A2)	[Achour (1996)]
	• Individual was immunized with rec vaccinia gp160 SIMI and boosted with puri£ed recombinant gp160 SIMI • P18 MN and RF peptides were able to stimulate the HIV-speci£c CTL that arose in response to the SIMI vaccination, thus the P18 MN peptide (IGPGRAFYTT) and the P18 RF peptide (KGPGRVIYAT) could cross-react • The P18 IIIB peptide does not cross-react (RGPGRAFVTI in the epitope region) • gp160 SIMI primed immune cells could generate a signi£cantly broader speci£city when stimulated with P18 MN or P18RF peptides, but not P18 IIIB				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	IIIB peptide	murine(D)	[Nehete (1995)]
	• RGPGRAFVTI was de£ned as the optimal peptide for vaccination, out of RIQRGPGRAFVTIGK • This peptide, in a carrier-free form in Freund's adjuvant, could stimulate Env speci£c CTL in BALB/c mice				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	IIIB peptide	murine(D^d)	[Takahashi (1993)]
	• Successful priming with vaccination of peptide pulsed splenic dendritic cells				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	IIIB peptide	murine(D^d)	[Takahashi (1996)]
	• Exposure of CD8+ CTL to free peptide corresponding to the epitope results in strong inhibition of the CTL response to targets presensitized with the same peptide • The authors propose this is due to a "self-veto'', where the CTL is inactivated by a CD8+ cell carrying the appropriate peptide-MHC complex				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	Env(318–327)	RGPGRAFVTI		murine(H-2^d)	[Lopez (2000)]
	• A series of protease and proteasome inhibitors was used to identify elements of the processing pathway of this epitope, called p18, both from within Env and from within a chimeric hepatitis B protein which allows proper processing • Lactacystin, a proteasome inhibitor, partially inhibits endogenous processing of p18 epitope suggesting both a proteasome pathway and an additional pathway can be used • Both TAP dependent and TAP-independent pathways can be used • 1,10-phenanthrolin (metallopeptidases inhibitor) blocks epitope presentation demonstrating metalloproteinase processing in the Tap-dependent pathway • The Tap-independent pathway does not involve processing by metalloproteinases • This epitope is immunodominant in mice, and is presented by multiple human HLA alleles – it as been suggested that the high processing ef£ciency of this epitope might result in poor presentation of co-expressed epitopes			
gp160(311–320)	gp120()	RGPGRAFVTI	Polyepitope encoding DNA in VVA	murine(H-2^d)	[Hanke (1998b), Hanke (1998a)]
	• This murine epitope was incorporated into a vaccine of CTL epitopes expressed together including 20 HIV epitopes recognized by humans from 12 HLA types, one murine HIV epitope and three macaque HIV epitopes, delivered in a vaccinia virus Ankara (VVA) construct • The murine vaccination was more effective at generating CTL when given i.v. rather than i.m.				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	Combination peptide vaccine	murine BALB/c(H-2^d)	[Hamajima (1997)]
	• B cell epitope HGP-30 also serves as a CTL epitope • Vaccine combined HGP-30, V3 loop peptide variants, and CD4 binding site peptide • IL-12 expression plasmid included with the vaccination enhanced the CTL response				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	HIV-1 DNA vaccine (gp160-CMV) with 8 Br-cAMP as adjuvant	murine(H-2^d)	[Arai (2000)]
	• Low-dosage 8 Br-cAMP given in combination with a DNA vaccine to BALB/c mice increased IgG and sIgA levels, and enhanced Th1, Th2 and CTL activity – the adjuvant activity may be mediated by activation of the CMV promotor in the DNA vaccine				
gp160(311–320)	gp120(318–327 IIIB)	RGPGRAFVTI	rec vaccinia-gp160	murine(H-2^d)	[Goletz (1997)]
	• Anthrax lethal toxin can deliver proteins to the cytosol of eukaryotic cells • A fusion protein linking the delivery domain of the anthrax protein to gp120 achieved cellular uptake, and gp120 was processed allowing presentation of this V3 epitope to CTL *in vitro*				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	gp120(318–327 IIIB)	RGPGRAFVTI	vaccinia IIIB gp160	murine(H-$2^{d,p,u}$)	[Shirai (1997)]
	• Three class I MHC, H-$2^{d,p,u}$, that differ in sequence and serology, cross-present this peptide to T cells of each of the other haplotypes • The amino acids R, F, and I are each critical for strong CTL activity with all three MHC molecules				
gp160(311–320)	gp160()	RGPGRAFVTI	Polyepitope encoding DNA expressed in modi£ed virus Ankara (MVA) DNA vectors	murine(H-2^{d17})	[Hanke (1998a)]
	• MVA is an attenuated vaccinia that can not replicate in mammalian cells – strings of CTL epitopes were delivered and expressed in a MVA DNA vector • γ IFN and CTL activity were induced after a single vaccination • An MVA boost enhanced the response				
gp160(311–320)	gp160()	RGPGRAFVTI	Env DNA prime/boost with IL-12	murine(H-2d)	[Gherardi (2000)]
	• Induction of HIV-1 speci£c CD8 gamma IFN secreting cells was enhanced when IL-12 and Env were given together in a prime, followed by a VV expressing Env boost • If IL-12 was also delivered as a boost from the viral vector, impairment of the IL-12 effects was noted, indicating that the vaccination schedule can be a critical parameter for success with DNA and vaccinia vectors used in combination with immunomodulators • The negative effect observed when IL-12 was delivered with the boost involved nitric oxide				
gp160(311–320)	Env()	RGPGRAFVTI	DNA vaccine pCMV160IIIB/REV with IL-15 and IL-2 or IL-12 expression plasmids	murine(H-2d)	[Xin (1999)]
	• Intranasal immunization of BALB/c mice with HIV DNA and IL-15 plasmid induced increased Th1 and CTL responses • Co-administration of IL-15 with IL-12 or IL-2 plasmids did not alter the effect of IL-15 • Both the CTL (peptide pulsed targets) and DTH response (injection of peptide into footpad) to this peptide was monitored • The Ab response to NNTRKSIRIQRGPGRAFVTIGKIGN was monitored, and IL-15 co-administration resulted in a decrease in the IgG1/IgG2a ratio				
gp160(311–320)	Env()	RGPGRAFVTI	HIV-1 peptide p18 in vaccinia (vp18) or Sindbis (SINp18) vector	murine(H-2d)	[Villacres & Bergmann(1999)]
	• HIV-1 epitope p18 was expressed in two different vaccine vectors and the CTL response was compared in BALB/c mice • Class I tetramer staining showed that up to 13% of the CD8+ splenocytes were p18 speci£c in the acute response using vaccinia, only 4% using Sindbis • vp18 had more gamma IFN secreting splenocytes and activated CD4+ and CD8+ T cells • The overall decline in CD8+ T cells in the transition into memory was 2-3 fold for both vectors • Sindbis virus recombinants induced protective memory cytotoxic T cells, although reduced quantitatively, without vaccinia associated in¤amation and replication				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	Env()	IGPGRARYAR	MVA gp160 89.6	murine BALB/c(H-2D)	[Belyakov (1998b)]
	• Recombinant modi£ed vaccinia virus Ankara (MVA), an attenuated vaccina which has lost the ability to replicate in mammalian cells, was used as the live vector for this vaccine study • A single intrarectal mucosal immunization resulted in long lasting mucosal CTL responses and production of proin¤ammatory cytokines in mucosal sites, indicating that MVA was as effective in inducing mucosal CTL as replicating recombinant vaccinia				
gp160(311–320)	Env()	IGPGRARYAR	HIV peptide PCLUS3-18IIIB	murine BALB/c(H-2D)	[Belyakov (1998a)]
	• HIV protection and mucosal CTL response was studied – an HIV peptide immunogen could protect against gp160 expressing vaccinia in a murine intrarectal challenge system in which neutralizing Abs did not play a role, demonstrating mucosal CTL at the site of exposure can be protective				
gp160(311–320)	gp120()	IGPGRAFYTT	*B. abortus*-peptide conjugate	murine(H-2D^d)	[Lapham (1996)]
	• *B. abortus*-peptide conjugate induced a virus-speci£c CTL response in CD4+ lymphocyte depleted mice				
gp160(311–320)	gp160()	RGPGRAFVTI	rec non-replicating adenoviruses (RAd501 (env) and RAd46 (rev) or RAd142 (env+rev))	murine(H-2D^d)	[Bruce (1999)]
	• A good HIV-1 Env immune response using non-replicating adenovirus vectors in BALB/c mice is dependent upon the presence of the stimulatory tat/rev 5‘splice-donor site sequence and the presence of Rev • Administration of monocistronic RAd501 expressing env and RAd46 expressing rev resulted in a positive CTL response, but required two immunizations for a CTL response comparable to that induced by the bicistronic virus RAd142 • Administration of RAd501 alone gave a low CTL response, but no humoral response, suggesting a lower level of antigen may be required to stimulate CTL				
gp160(311–320)	gp120()	IGPGRAFYTT	*B. abortus*-peptide conjugate	murine(H-2D^d)	[Lapham (1996)]
	• *B. abortus*-peptide conjugate induced a virus-speci£c CTL response in CD4+ lymphocyte depleted mice				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	peptide	murine(H-2D^d)	[Takeshita (1995)]
	• XGPXRXXXXI are critical for binding, consistent with H-2D^d motif XGPX(RKH)XXX(X)(LIF)				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	Env()	RGPGRAFTVTI	multi-epitope DNA vaccine	murine(H-2D^d)	[Hanke & McMichael(1999), Hanke (1999)]
	• Vaccinated mice elicited a CTL response to a gene gun-delivered multiepitope vaccine to two epitopes studied that are known to elicit CTL in mice: SYIPSAEKI from Plasmodium berghei and RGPGRAFTVTI from HIV-1 Env • Different vaccination protocols were tested and it was found that a gene gun mediated delivery followed by an MVA boost was as good as i. m. immunization followed by a MVA boost – this is advantageous as gene gun delivery requires far less DNA than i.m. DNA priming • CTL activity was high (60% - 70% speci£c lysis at effector target) when vaccinated with a single gene gun immunization and an MVA boost, and improved with two gene gun vaccinations				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	A rapidly degraded form of Env	murine(L^d)	[Tobery & Siliciano(1997)]
	• An HIV-1 Env vaccine was targeted for rapid cytoplasmic degradation • The rapidly degraded form rapidly stimulated CTL to this peptide, faster than the normal vaccinia-env • The rapidly degraded form also stimulated greater speci£c CTL lysis and higher CTLp frequencies than normal Env • Similar results were obtained for a Nef protein designed for rapid degradation				
gp160(314–322)	gp120(314–322)	GRAFVTIGK	no CTL shown	human(B27)	[Jardetzky (1991)]
	• Study of peptide binding to HLA-B27				

Table 10: **All De£ned Epitopes within the 20mer, regardless of HLA type**

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(308–322)	gp160()	RIHIGPGRAFYTTKN	Immunization with HIV Env peptides in Montanide ISA 51	human()	[Pinto (1999)]
	• Peptide P18: Eight HIV+ individuals were vaccinated with peptides containing speci£c T helper, CTL and Ab epitopes in a Phase I trial • Four displayed a 4-fold increase in PCLUS 3-18 MN-speci£c T helper responses • One patient developed a new, sustained P18MN-peptide-speci£c CTL response – the patient‘s HLA haplotype was A2,30; B53,7; Cw2,4, and anti-HLA A2 antibody did not inhibit the response, suggesting it was not A2 • Patients with low baseline Ab levels developed an increase of neutralizing Ab titers • No signi£cant change was observed in plasma HIV viral loads and CD4 cell counts				
gp160(308–322)	gp120()	RIHIGPGRAFYTTKN	HIV-1 infection	chimpanzee()	[Lubeck (1997)]
	• Epitope-speci£c CTL detected in chimpanzees immunized with adenovirus-HIV-1 MN gp160 recombinant • CTL response may account for protection against subsequent HIV-1 SF2 challenge in a chimpanzee lacking neutralizing antibodies				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	HIV exposure	human()	[Pinto (1995)]
	• CTL and T helper cell reactivity in healthcare workers exposed to HIV				
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	HIV exposure	human()	[Pinto (1995)]
	• CTL and T helper cell reactivity in healthcare workers exposed to HIV				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	vaccinia IIIB gp160	human(A11)	[Achour (1994)]
	• One of 3 HLA type restrictions associated with this peptide				
gp160(308–322)	gp120(315–329 BRU)	RIQRGPGRAFVTIGK	HIV-1 infection	human(A2)	[Dadaglio (1991)]
	• De£ned through blocking CTL activity, and Env deletions				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	HIV-1 infection	human(A2)	[Clerici (1991)]
	• Helper and cytotoxic T cells can be stimulated by this peptide (P18)				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	gp160 vaccinia	human(A2, A3)	[Achour (1993)]
	• Two of 3 HLA type restrictions associated with this peptide				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	IIIB peptide	murine(D^d)	[Takahashi (1989a)]
	• R(8) F(10) MHC/peptide interaction				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	IIIB peptide	murine(D^d)	[Sastry (1992)]
• Free peptide injected into the footpad of a mouse could stimulate speci£c CTL					
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	peptide immunization	murine(D^d)	[Ahlers (1997b)]
• PCLUS 3-18MN synthetic peptide vaccine construct contained T1 helper epitope covalently linked to truncated P18 CTL epitope • A substitution in the T1 peptide stimulated an enhanced Th response and class II binding speci£city, which in turn enhanced CTL induction by vaccine • Construct PCLUS 3-18MN is currently in a phase I vaccine clinical trial					
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	MN gp160 vaccinia	murine(D^d)	[Takahashi (1989b)]
• Y(11 MN) exchange with V(11 IIIB) interchanges speci£cities					
gp160(308–322)	gp120(313–327 IIIB MN RF)	SITKGPGRVIYATGQ	RF gp160 vaccinia	murine(D^d)	[Takahashi (1992)]
• Comparison of MN, IIIB, and RF speci£cities, position 11 is critical					
gp160(308–322)	gp120()	RIQRGPGRAFVTIGK	Pr55 gag-env VLPs	murine(H-2^d)	[Deml (1997)]
• Env bound to virus-like particles (VLPs) can elicit a CTL response that is dependent on the amount of Env presented on the VLP					
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	DNA immunization	murine BALB/c(H-2^d)	[Fomsgaard (1998a)]
• Enhanced B and CTL responses to the V3 region occur following epidermal immunization by gene gun with a chimeric DNA vaccine of V3-hepatitis B surface antigen relative to a gp160 plasmid vaccine					
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	peptide vaccine	murine BALB/c(H-2^d)	[Ahlers (1996), Ahlers (1997a)]
• Vaccine constructs containing helper, antibody and CTL peptide epitopes induce strong Th1, CTL and NAb responses against the autologous HIV-1 virus • The peptide CTL response was as cross-reactive as one elicited by a vaccinia construct expressing rgp160 MN • GM-CSF and IL-12 were the two cytokines most effective for inducing and boosting CTLs					
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	V3:Ty-Virus-like particles	murine(H-2^d)	[Layton (1993)]
• V3-Ty-Virus-like particles can induce type-speci£c CTL in mice in the absence of adjuvant					

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	vaccinia IIIB gp160	murine(H-$2^{d,p,u,q}$)	[Shirai (1992), Shirai (1993)]
	• In a murine system multiple class I molecules can present this peptide, called P18, to CTL, including H-2D^d, H-2D^p, H-2D^q, H-2L^q • The MHC class I molecule D^d as well as H-$2^{u,p,q}$, were found to present peptides P18 and HP53 • The V-β usage in T cells showing cross-reaction between these two peptides was conserved for H-$2^{d,u,p}$, but not in H-2^q				
gp160(308–322)	gp120()	RIQRGPGRAFVTIGK	gag-V3 fusion	murine(H-2d)	[Grif£ths (1993)]
	• Gag-V3 fusion protein immunization elicited V3 CTL response in mice				
gp160(308–322)	gp120()	RIQRGPGRAFVTIGK	DNA vaccine pV1J-gp120	murine(H-2d)	[Barouch (1998)]
	• This study showed that a response to an HIV-1 DNA vaccine could be either augmented or suppressed by plasmid Cytokine/Ig administration				
gp160(308–322)	gp160()	RIHIGPGRAFYTTKN	DNA vaccine, MN gp160	murine BALB/c and C57/BL6(H-2d and H-2b)	[Fomsgaard (1998b)]
	• CTL responses to a primary gene gun vaccination were rapid and strong for several methods of vaccinations: i.m., bupivacaine pretreatment, cardiotoxin pretreatment or gene gun – the CTL response was more rapid and consistent than the antibody response				
gp160(308–322)	gp160()	GIHIGPGRAFYAARK	HIV-gp160, an Env CTL epitope (E7), and the mucosal adjuvant LT(R192G)	murine(H-2D^d)	[Morris (2000)]
	• LT(R192G) induces gp160-speci£c serum and mucosal IgG1 and IgG2a, systemic CTL activity and Th1 and Th2 cytokine responses upon internasal immunization				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	Intranasal peptide with cholera toxin as a mucosal adjuvant	murine(H-2D^d)	[Porgador (1997)]
	• IIIB peptide referred to as R15K • Peptide-speci£c CTLs were induced after *in vitro* restimulation with peptide-pulsed targets • R15K was superior at inducing CTL compared to the RGPGRAFVTI, in contrast to the £ndings of Nehete *et al.* • Memory CTL responses were induced				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	Rec vaccinia expressing HIV-1 P18 IIIB in an H1 in¤uenza hemagglutinin (HA) gene cassette	(H-2D^d)	[Chiba (1999)]
	• Vaccine was capable of priming P18IIIB speci£c CTL in BALB/c mice, but could not induce a P18IIIB-speci£c antibody response				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(308–322)	gp120()	RIHIGPGRAFYTTKN	V3 loop peptides	murine(H-2D^{d})	[Casement (1995)]
	• V3 peptides from MN and SC induce murine CTL that are cross-reactive with diverse strains				
gp160(308–322)	gp120(313–327 MN)	RIHIGPGRAFYTTKN	MN rgp120 with QS-21 adjuvant	murine(H-2D^{d})	[Newman (1997)]
	• MN vaccine induced CTL reactive with MN, IIIB and RF vaccinia-expressed Env, but not this peptide				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	IIIB rgp120 with QS-21 adjuvant	murine(H-2D^{d})	[Newman (1997)]
	• IIIB vaccine induced IIIB type-speci£c CTL to this peptide (P18), and an additional Env CTL response that was cross-reactive				
gp160(308–322)	gp120(315–329)	RIQRGPGRAFVTIGK	vaccinia IIIB gp160	murine(H-2D^{d})	[Takahashi (1988)]
	• V3 loop CTL response in mice vaccinated with gp160				
gp160(308–322)	gp120(315–329)	RIQRGPGRAFVTIGK	18IIIB peptides coated with peptide	murine BALB/c(H-2D^{d})	[Fukasawa (1998)]
	• The peptide RIQRGPGRAFVTIGK was incorporated into liposomes and given as a subcutaneous injection, which induces a MHC class I restricted CTL response in mice • Liposomes coated with oligomannose show no toxicity and can elicit a potent CTL response upon a single subcutaneous infection, while non-coated liposomes do not, suggesting that oligomannose may be a good adjuvant for CTL responses				
gp160(308–322)	gp120(315–329 IIIB)	RIQRGPGRAFVTIGK	rec vaccinia gp160	murine(H-2D^{d,p,q}, H-2^{u})	[Shirai (1996)]
	• Multiple murine MHC can cross-present this epitope (P18) and HP53, DRVIEVVQGAYRAIR, to speci£c CTL				
gp160(309–317)	gp120(310–318 SF2)	IYIGPGRAF	HIV-1 infection	human(A*2402)	[Ikeda-Moore (1997)]
	• De£ned using reverse immunogenetics – 59 HLA-A*2402 binding peptides were predicted by searching for A*2402 anchors in HIV proteins (Tyr at 2, and Phe, Leu or Ile at the C term) – 53 of the 59 peptides bound A*2402 • This peptide induced CTL in 1/4 HIV-1+ people tested • IYIGPGRAF bound to A*2402 strongly, the epitope can be processed in a vaccinia construct and presented – no speci£c CTL clones were obtained				
gp160(310–323)	gp120(315–328 MN)	HIGPGRAFYTTKNI	vCP205, canary pox vector, MN gp120 + Gag/Pro IIIB, HIV-1 pseudovirion boost	murine(H-2D^{d})	[Arp (1999)]
	• Epitope p97: HIV-1 pseudovirion boost enhanced the CTL to this epitope in immunized BALB/ c mice as measured by CTL lysis and IFN gamma production				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–319)	gp120(312–320 SF2)	IGPGRAFHT	DNA gp120-plasmid immunization	murine(D^d)	[Selby (1997)]
	• Murine CTL response to peptide observed after immunization with DNA plasmid containing HIV-1 (SF2) gp120 gene regulated by bacteriophage T7 promoter • CTL response required coadministration of rec vaccinia virus expressing T7 RNA polymerase or T7 RNA polymerase soluble protein				
gp160(311–319)	gp120()	IGPGRAFHT	gp120(SF2) DNA vaccine, rgp120 protein boost	murine(H-2D^d)	[Barnett (1997)]
	• CTL were induced by vaccine, and restimulated *in vitro* with V3 peptide • DNA vaccine with protein boost stimulated both CTL and antibodies • Strains SF2 (IGPGRAFHT), US4 (IGPGRAFYA), and CM235 (IGPGQVFYR) were tested				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	DNA gp160 plasmid + peptide boost	Macaca fuscata()	[Okuda (1997)]
	• Murine BALB/c (H-2^d) and macaque both showed highest level of CTL vaccine response when a DNA vaccine was boosted with a peptide including four peptide subtypes of the V3 region, HPG-30 and a fragment of the CD4 binding region				
gp160(311–320)	gp120(318–327)	RGPGRAFVTI	HIV-1 infection	human()	[Kmieciak (1998)]
	• Increased CTL response to cells expressing a VV construct ΔV3 mutant compared with a full-length env gene product • This epitope doesn„t have A2 anchors, but has features that confer promiscuous A2 binding, which may relate to the inhibitory effect seen in this paper				
gp160(311–320)	Env()	RGPGRAFVTI	IIIB DNA vaccine with MIP-1alpha expression vector	murine BALB/c()	[Lu (1999)]
	• A MIP-1 alpha expression plasmid increased the CTL response to this DNA vaccine, as well as the T help response, presumably by the MIP-1 alpha interacting with T lymphocytes and macrophages				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	CTL line from HIV-donor	human(A*0201)	[Alexander-Miller (1996)]
	• This immunogenic peptide does not have the known binding motif for A2.1 • The same optimal peptide for this human HLA-A2.1 epitope was observed for a murine H-2 D^d epitope				
gp160(311–320)	gp120(311–320 IIIB)	RGPGRAFVTI	?	human(A*0201)	[Brander & Goulder(2001)]
	• C. Brander notes this is an A*0201 epitope				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	vaccinia IIIB gp160	human(A2)	[Achour (1996)]
	• Individual was immunized with rec vaccinia gp160 IIIB and boosted with puri£ed gp160 • Lysis only occurs with IIIB P18 peptide pulsed onto autologous targets; MN, RF, SIMI P18 peptides fail to stimulate CTL • Restimulating immune cells from gp160 IIIB vaccinees with MN, RF, or SIMI P18 did not enhance the MN, RF, or SIMI speci£c CTL response				
gp160(311–320)	gp160(318–327 SIMI)	MGPKRAFYAT	vaccinia SIMI gp160	human(A2)	[Achour (1996)]
	• Individual was immunized with rec vaccinia gp160 SIMI and boosted with puri£ed recombinant gp160 SIMI • P18 MN and RF peptides were able to stimulate the HIV-speci£c CTL that arose in response to the SIMI vaccination, thus the P18 MN peptide (IGPGRAFYTT) and the P18 RF peptide (KGPGRVIYAT) could cross-react • The P18 IIIB peptide does not cross-react (RGPGRAFVTI in the epitope region) • gp160 SIMI primed immune cells could generate a signi£cantly broader speci£city when stimulated with P18 MN or P18RF peptides, but not P18 IIIB				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	IIIB peptide	murine(D)	[Nehete (1995)]
	• RGPGRAFVTI was de£ned as the optimal peptide for vaccination, out of RIQRGPGRAFVTIGK • This peptide, in a carrier-free form in Freund's adjuvant, could stimulate Env speci£c CTL in BALB/c mice				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	IIIB peptide	murine(D^d)	[Takahashi (1993)]
	• Successful priming with vaccination of peptide pulsed splenic dendritic cells				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	IIIB peptide	murine(D^d)	[Takahashi (1996)]
	• Exposure of CD8+ CTL to free peptide corresponding to the epitope results in strong inhibition of the CTL response to targets presensitized with the same peptide • The authors propose this is due to a "self-veto'', where the CTL is inactivated by a CD8+ cell carrying the appropriate peptide-MHC complex				

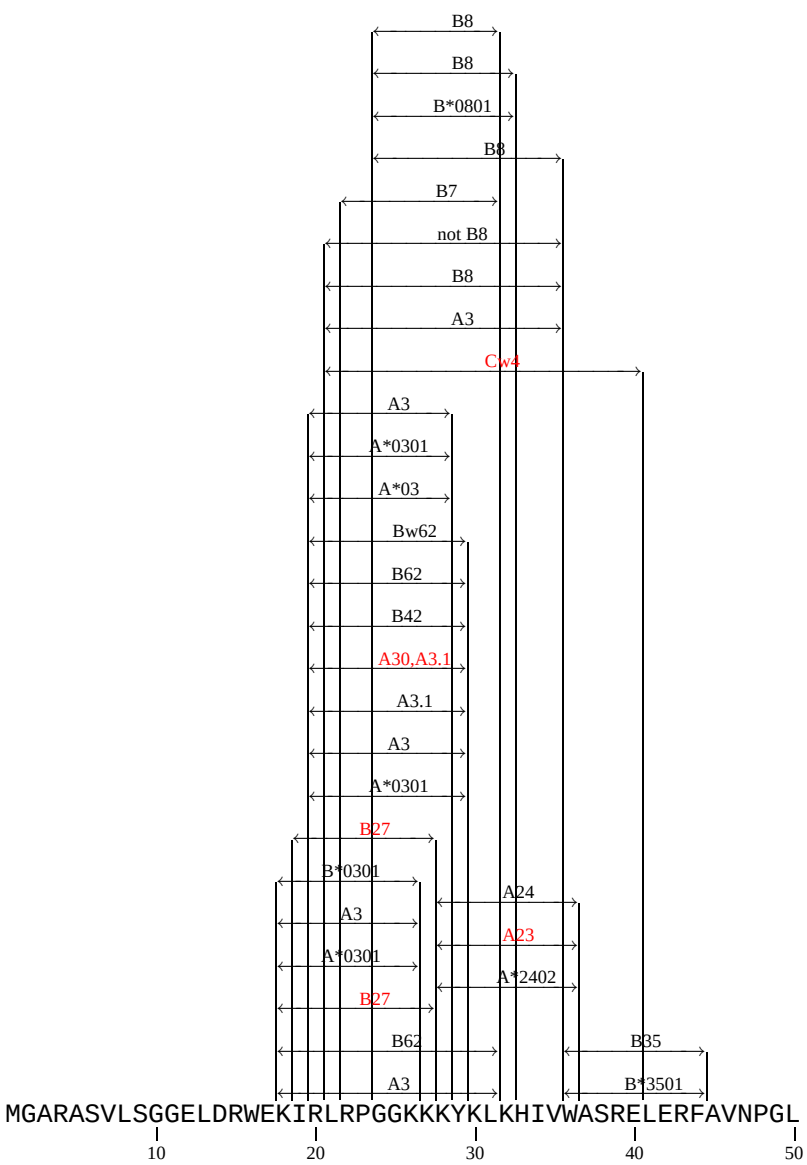
HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	Env(318–327)	RGPGRAFVTI		murine(H-2^d)	[Lopez (2000)]
	• A series of protease and proteasome inhibitors was used to identify elements of the processing pathway of this epitope, called p18, both from within Env and from within a chimeric hepatitis B protein which allows proper processing • Lactacystin, a proteasome inhibitor, partially inhibits endogenous processing of p18 epitope suggesting both a proteasome pathway and an additional pathway can be used • Both TAP dependent and TAP-independent pathways can be used • 1,10-phenanthrolin (metallopeptidases inhibitor) blocks epitope presentation demonstrating metalloproteinase processing in the Tap-dependent pathway • The Tap-independent pathway does not involve processing by metalloproteinases • This epitope is immunodominant in mice, and is presented by multiple human HLA alleles – it as been suggested that the high processing ef£ciency of this epitope might result in poor presentation of co-expressed epitopes			
gp160(311–320)	gp120()	RGPGRAFVTI	Polyepitope encoding DNA in VVA	murine(H-2^d)	[Hanke (1998b), Hanke (1998a)]
	• This murine epitope was incorporated into a vaccine of CTL epitopes expressed together including 20 HIV epitopes recognized by humans from 12 HLA types, one murine HIV epitope and three macaque HIV epitopes, delivered in a vaccinia virus Ankara (VVA) construct • The murine vaccination was more effective at generating CTL when given i.v. rather than i.m.				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	Combination peptide vaccine	murine BALB/c(H-2^d)	[Hamajima (1997)]
	• B cell epitope HGP-30 also serves as a CTL epitope • Vaccine combined HGP-30, V3 loop peptide variants, and CD4 binding site peptide • IL-12 expression plasmid included with the vaccination enhanced the CTL response				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	HIV-1 DNA vaccine (gp160-CMV) with 8 Br-cAMP as adjuvant	murine(H-2^d)	[Arai (2000)]
	• Low-dosage 8 Br-cAMP given in combination with a DNA vaccine to BALB/c mice increased IgG and sIgA levels, and enhanced Th1, Th2 and CTL activity – the adjuvant activity may be mediated by activation of the CMV promotor in the DNA vaccine				
gp160(311–320)	gp120(318–327 IIIB)	RGPGRAFVTI	rec vaccinia-gp160	murine(H-2^d)	[Goletz (1997)]
	• Anthrax lethal toxin can deliver proteins to the cytosol of eukaryotic cells • A fusion protein linking the delivery domain of the anthrax protein to gp120 achieved cellular uptake, and gp120 was processed allowing presentation of this V3 epitope to CTL *in vitro*				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	gp120(318–327 IIIB)	RGPGRAFVTI	vaccinia IIIB gp160	murine(H-$2^{d,p,u}$)	[Shirai (1997)]
	• Three class I MHC, H-$2^{d,p,u}$, that differ in sequence and serology, cross-present this peptide to T cells of each of the other haplotypes • The amino acids R, F, and I are each critical for strong CTL activity with all three MHC molecules				
gp160(311–320)	gp160()	RGPGRAFVTI	Polyepitope encoding DNA expressed in modi£ed virus Ankara (MVA) DNA vectors	murine(H-2^{d17})	[Hanke (1998a)]
	• MVA is an attenuated vaccinia that can not replicate in mammalian cells – strings of CTL epitopes were delivered and expressed in a MVA DNA vector • γ IFN and CTL activity were induced after a single vaccination • An MVA boost enhanced the response				
gp160(311–320)	gp160()	RGPGRAFVTI	Env DNA prime/boost with IL-12	murine(H-2d)	[Gherardi (2000)]
	• Induction of HIV-1 speci£c CD8 gamma IFN secreting cells was enhanced when IL-12 and Env were given together in a prime, followed by a VV expressing Env boost • If IL-12 was also delivered as a boost from the viral vector, impairment of the IL-12 effects was noted, indicating that the vaccination schedule can be a critical parameter for success with DNA and vaccinia vectors used in combination with immunomodulators • The negative effect observed when IL-12 was delivered with the boost involved nitric oxide				
gp160(311–320)	Env()	RGPGRAFVTI	DNA vaccine pCMV160IIIB/REV with IL-15 and IL-2 or IL-12 expression plasmids	murine(H-2d)	[Xin (1999)]
	• Intranasal immunization of BALB/c mice with HIV DNA and IL-15 plasmid induced increased Th1 and CTL responses • Co-administration of IL-15 with IL-12 or IL-2 plasmids did not alter the effect of IL-15 • Both the CTL (peptide pulsed targets) and DTH response (injection of peptide into footpad) to this peptide was monitored • The Ab response to NNTRKSIRIQRGPGRAFVTIGKIGN was monitored, and IL-15 co-administration resulted in a decrease in the IgG1/IgG2a ratio				
gp160(311–320)	Env()	RGPGRAFVTI	HIV-1 peptide p18 in vaccinia (vp18) or Sindbis (SINp18) vector	murine(H-2d)	[Villacres & Bergmann(1999)]
	• HIV-1 epitope p18 was expressed in two different vaccine vectors and the CTL response was compared in BALB/c mice • Class I tetramer staining showed that up to 13% of the CD8+ splenocytes were p18 speci£c in the acute response using vaccinia, only 4% using Sindbis • vp18 had more gamma IFN secreting splenocytes and activated CD4+ and CD8+ T cells • The overall decline in CD8+ T cells in the transition into memory was 2-3 fold for both vectors • Sindbis virus recombinants induced protective memory cytotoxic T cells, although reduced quantitatively, without vaccinia associated in¤amation and replication				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	Env()	IGPGRARYAR	MVA gp160 89.6	murine BALB/c(H-2D)	[Belyakov (1998b)]
	• Recombinant modi£ed vaccinia virus Ankara (MVA), an attenuated vaccina which has lost the ability to replicate in mammalian cells, was used as the live vector for this vaccine study • A single intrarectal mucosal immunization resulted in long lasting mucosal CTL responses and production of proin¤ammatory cytokines in mucosal sites, indicating that MVA was as effective in inducing mucosal CTL as replicating recombinant vaccinia				
gp160(311–320)	Env()	IGPGRARYAR	HIV peptide PCLUS3-18IIIB	murine BALB/c(H-2D)	[Belyakov (1998a)]
	• HIV protection and mucosal CTL response was studied – an HIV peptide immunogen could protect against gp160 expressing vaccinia in a murine intrarectal challenge system in which neutralizing Abs did not play a role, demonstrating mucosal CTL at the site of exposure can be protective				
gp160(311–320)	gp120()	IGPGRAFYTT	*B. abortus*-peptide conjugate	murine(H-2D^d)	[Lapham (1996)]
	• *B. abortus*-peptide conjugate induced a virus-speci£c CTL response in CD4+ lymphocyte depleted mice				
gp160(311–320)	gp160()	RGPGRAFVTI	rec non-replicating adenoviruses (RAd501 (env) and RAd46 (rev) or RAd142 (env+rev))	murine(H-2D^d)	[Bruce (1999)]
	• A good HIV-1 Env immune response using non-replicating adenovirus vectors in BALB/c mice is dependent upon the presence of the stimulatory tat/rev 5‘splice-donor site sequence and the presence of Rev • Administration of monocistronic RAd501 expressing env and RAd46 expressing rev resulted in a positive CTL response, but required two immunizations for a CTL response comparable to that induced by the bicistronic virus RAd142 • Administration of RAd501 alone gave a low CTL response, but no humoral response, suggesting a lower level of antigen may be required to stimulate CTL				
gp160(311–320)	gp120()	IGPGRAFYTT	*B. abortus*-peptide conjugate	murine(H-2D^d)	[Lapham (1996)]
	• *B. abortus*-peptide conjugate induced a virus-speci£c CTL response in CD4+ lymphocyte depleted mice				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	peptide	murine(H-2D^d)	[Takeshita (1995)]
	• XGPXRXXXXI are critical for binding, consistent with H-2D^d motif XGPX(RKH)XXX(X)(LIF)				

HXB2 Location	Author Location	Sequence	Immunogen	Species(HLA)	References
gp160(311–320)	Env()	RGPGRAFTVTI	multi-epitope DNA vaccine	murine(H-2D^d)	[Hanke & McMichael(1999), Hanke (1999)]
	• Vaccinated mice elicited a CTL response to a gene gun-delivered multiepitope vaccine to two epitopes studied that are known to elicit CTL in mice: SYIPSAEKI from Plasmodium berghei and RGPGRAFTVTI from HIV-1 Env • Different vaccination protocols were tested and it was found that a gene gun mediated delivery followed by an MVA boost was as good as i. m. immunization followed by a MVA boost – this is advantageous as gene gun delivery requires far less DNA than i.m. DNA priming • CTL activity was high (60% - 70% speci£c lysis at effector target) when vaccinated with a single gene gun immunization and an MVA boost, and improved with two gene gun vaccinations				
gp160(311–320)	gp160(318–327 IIIB)	RGPGRAFVTI	A rapidly degraded form of Env	murine(L^d)	[Tobery & Siliciano(1997)]
	• An HIV-1 Env vaccine was targeted for rapid cytoplasmic degradation • The rapidly degraded form rapidly stimulated CTL to this peptide, faster than the normal vaccinia-env • The rapidly degraded form also stimulated greater speci£c CTL lysis and higher CTLp frequencies than normal Env • Similar results were obtained for a Nef protein designed for rapid degradation				
gp160(314–322)	gp120(314–322)	GRAFVTIGK	no CTL shown	human(B27)	[Jardetzky (1991)]
	• Study of peptide binding to HLA-B27				

p17 CTL Map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B*0801
B8
B7
not B8
B8
A3
Cw4
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A*0301
A*03
Bw62
B62
B42
A30,A3.1
A3.1
A3
A*0301
B27
B*0301
A24
A3
A23
A*0301
A*2402
B27
B62
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40
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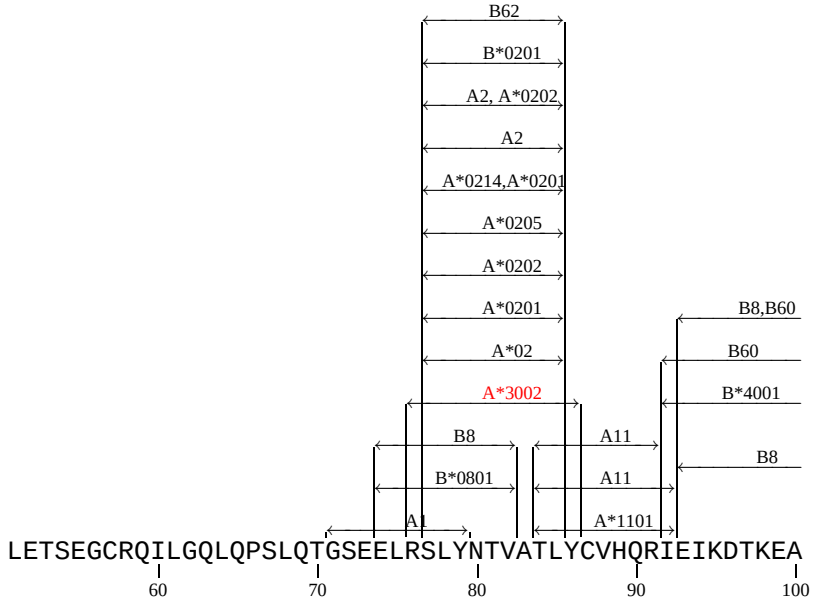
B62
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A2, A*0202
A2
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A*02
A*3002
B8
B*0801
A1
A11
A11
A*1101
B8,B60
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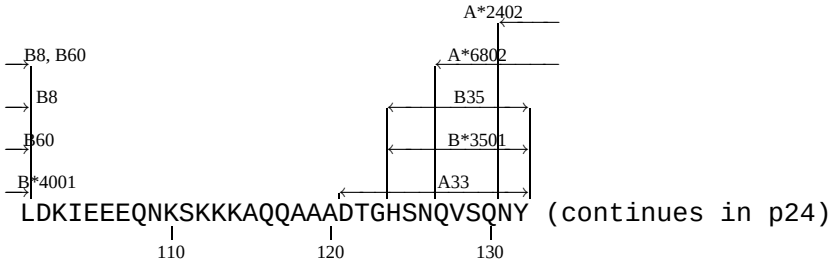
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B8, B60
A*6802
B8
B35
B60
B*3501
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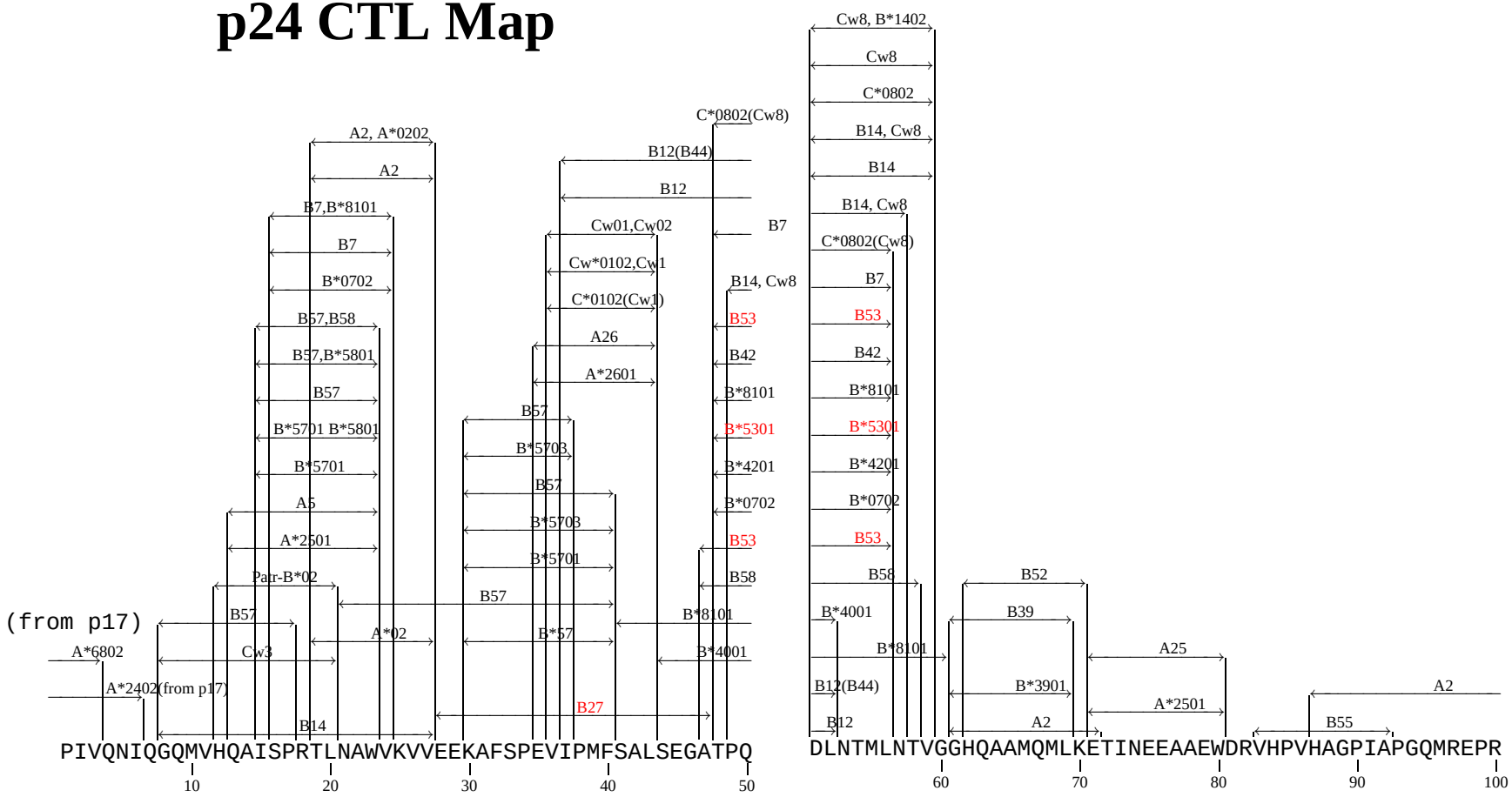
120
130

p24 CTL Map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A*2402(from p17)
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B7,B*8101
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B*0702
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B57,B*5801
B57
B*5701 B*5801
B*5701
A5
A*2501
Pair-B*02
B57
A*02
Cw3
B14
C*0802(Cw8)
B12(B44)
B12
Cw01,Cw02
Cw*0102,Cw1
C*0102(Cw1)
A26
A*2601
B57
B*5703
B57
B*5703
B*5701
B57
B*8101
B*57
B7
B14, Cw8
B53
B42
B*8101
B*5301
B*4201
B*0702
B53
B58
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B*4001
B27
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C*0802
B14, Cw8
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B14, Cw8
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B7
B53
B42
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B*5301
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B53
B58
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B52
B39
A25
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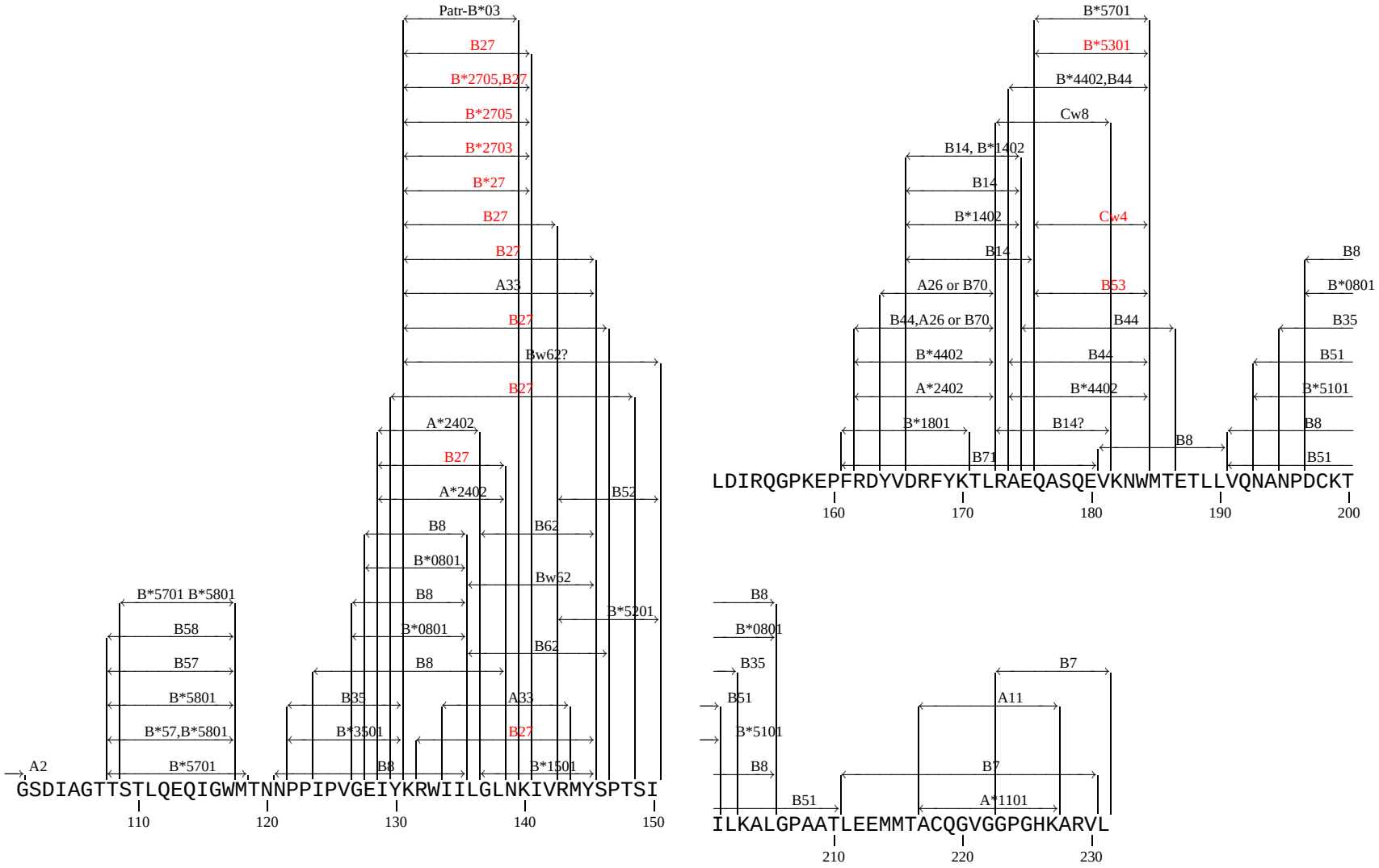
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A*2402
B27
A*2402
B52
B8
B62
B*0801
Bw62
B*5701 B*5801
B8
B*5201
B58
B*0801
B62
B57
B8
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B35
A33
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B*3501
B27
A2
B*5701
B8
B*1501
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B44
B35
B*4402
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B51
A*2402
B*4402
B*5101
B*1801
B14?
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B8
B71
B51
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160
170
180
190
200
B8
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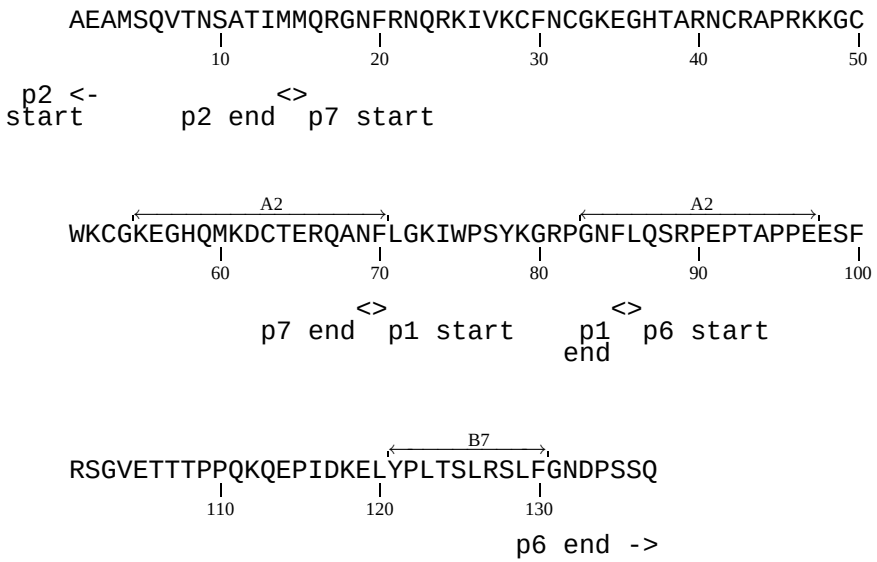
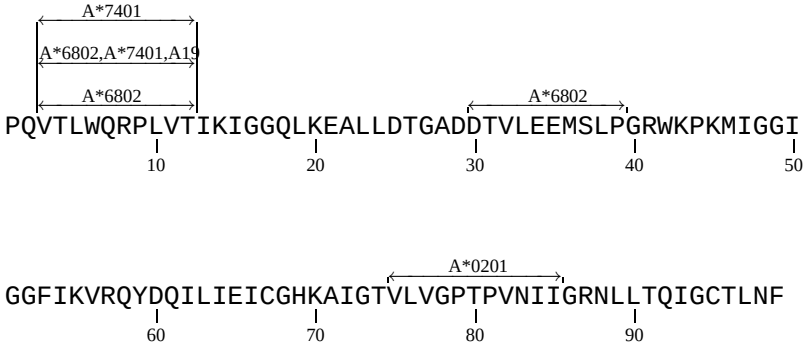
230

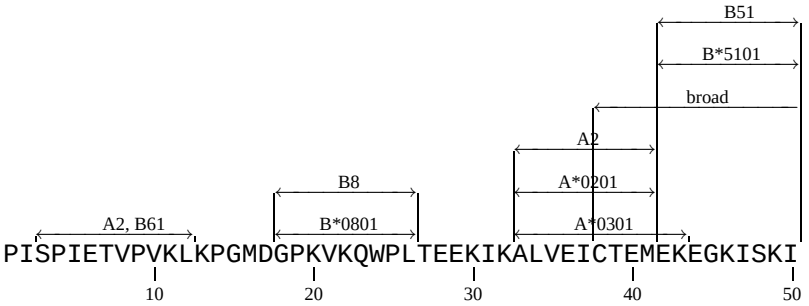
p2p7p1p6 CTL Map



Protease CTL Map



RT CTL Map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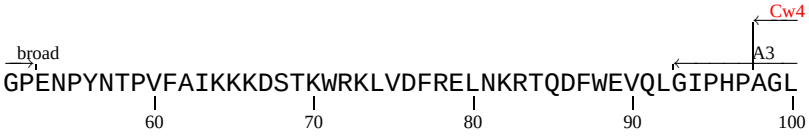
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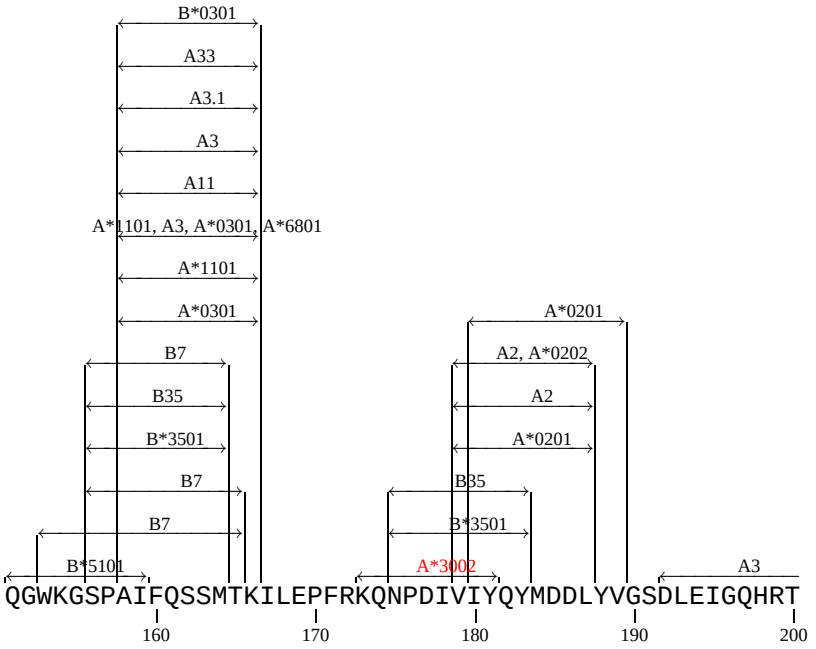
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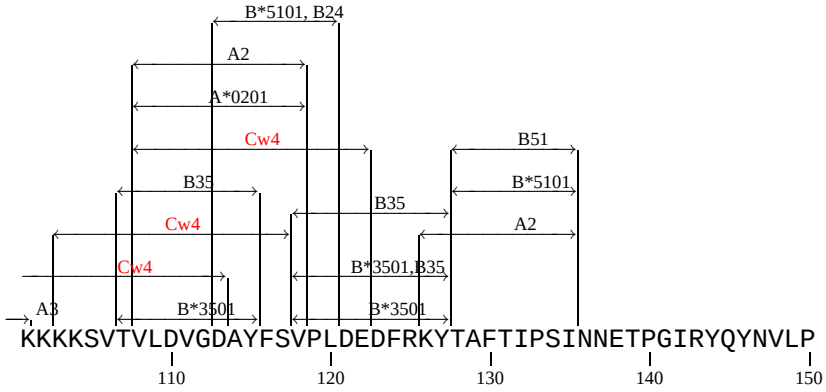
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Cw4
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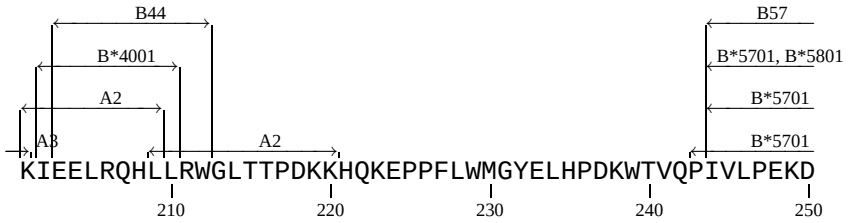
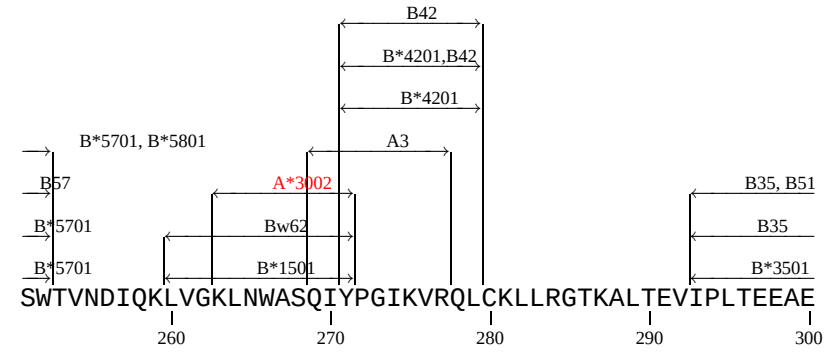
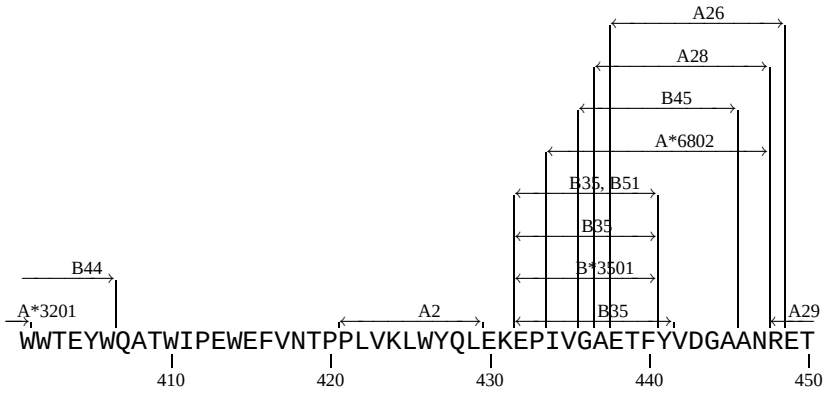
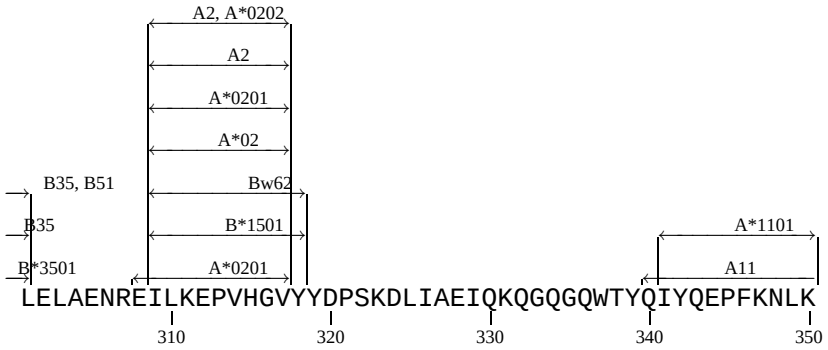
B*3501
B*3501
KKKKSVTVLDVGDAYFSVPLDEDFRKYTAFTIPSINNETPGIRYQYNVLP
110
120
130
140
150

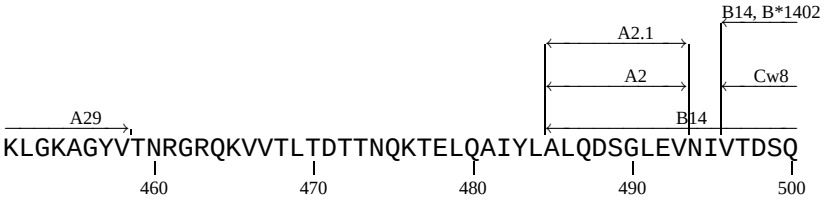

B44
B57
B*4001
B*5701, B*5801
A2
B*5701
A3
A2
B*5701
KIEELRQHLLRWGLTTPDKKHQKEPPFLWMGYELHPDKWTVQPIVLPEKD
210
220
230
240
250

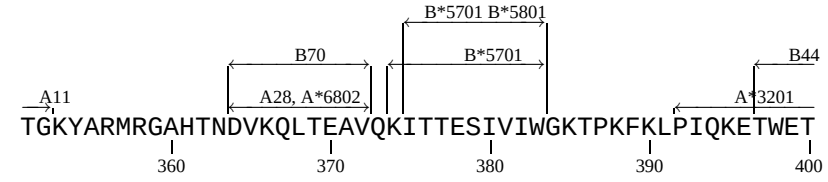


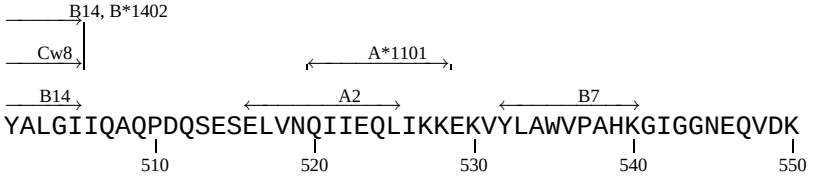


p15 RNase start <-





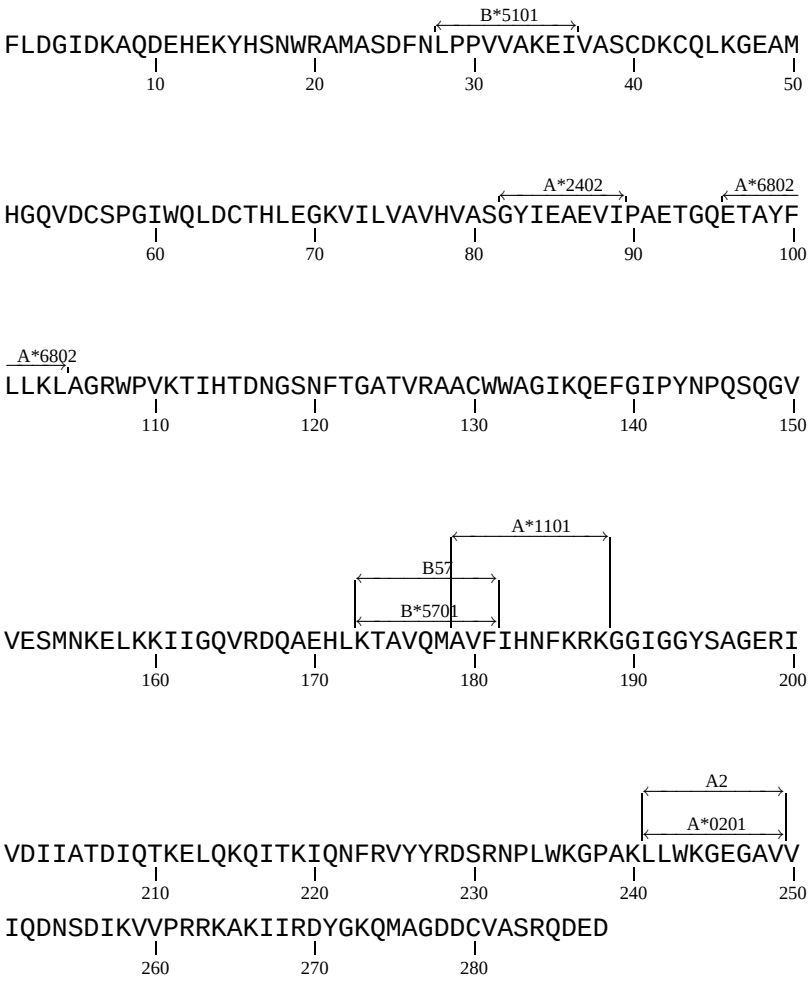




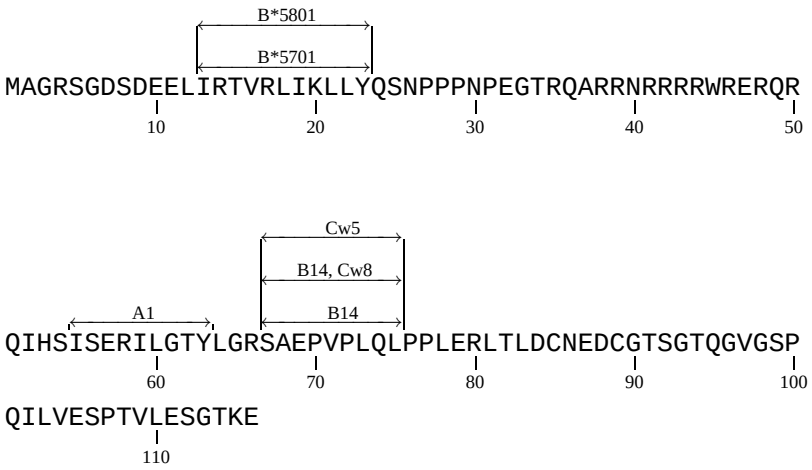
LVSAGIRKVL

-> p15 RNase end

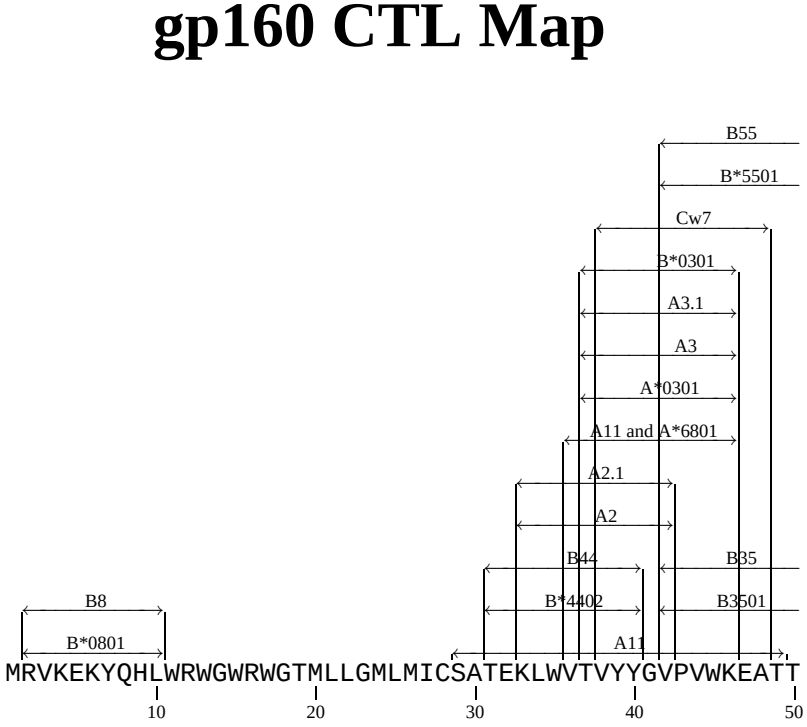
Integrase CTL Map



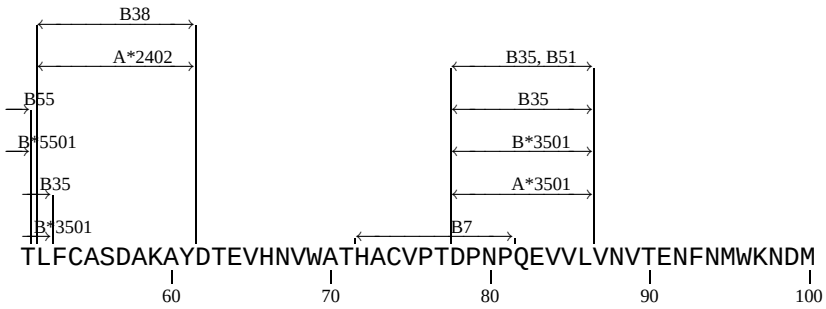
Rev CTL Map

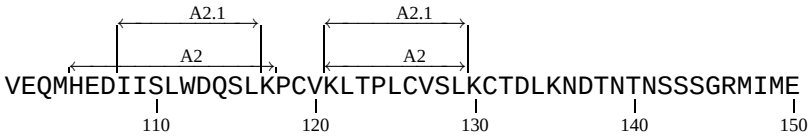


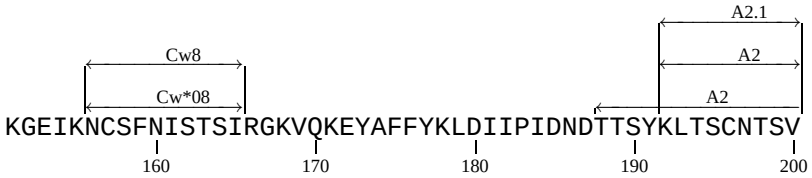
gp160 CTL Map

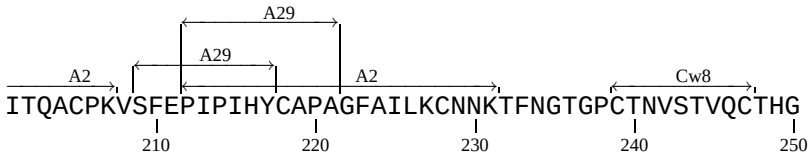


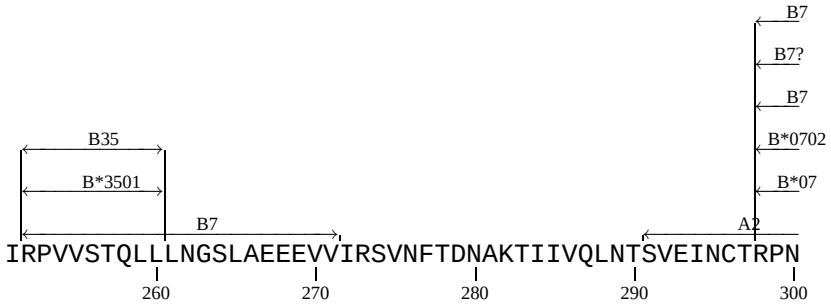
<- gp120 start

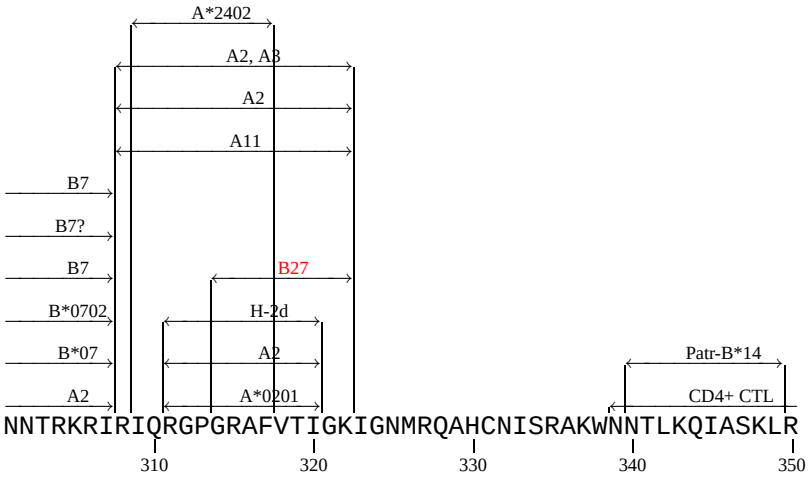


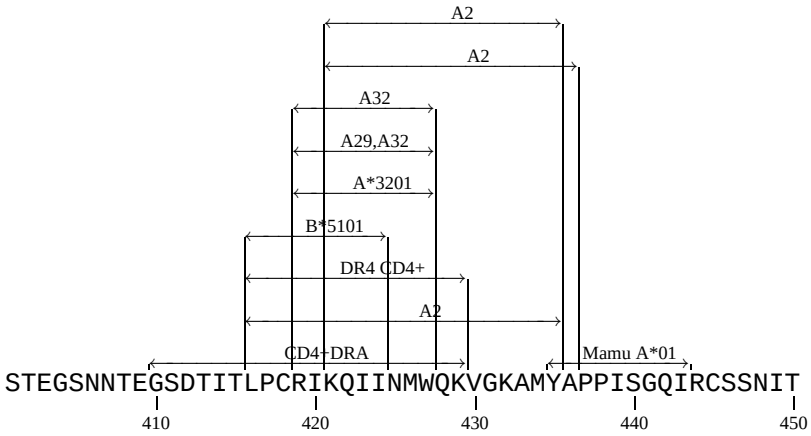


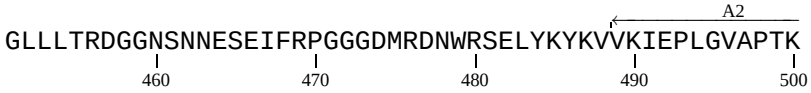


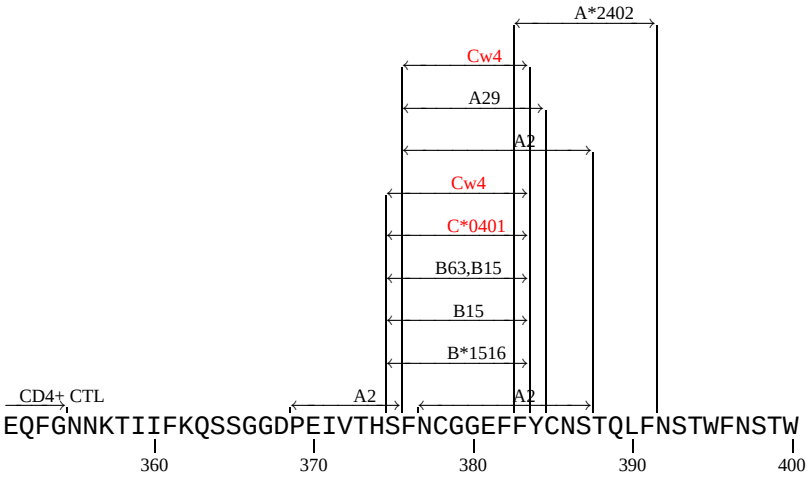




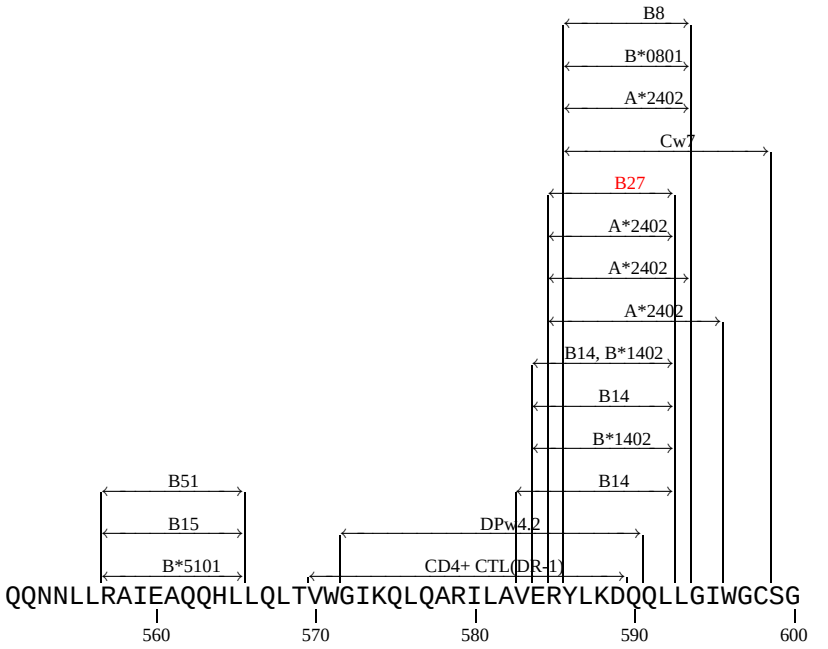


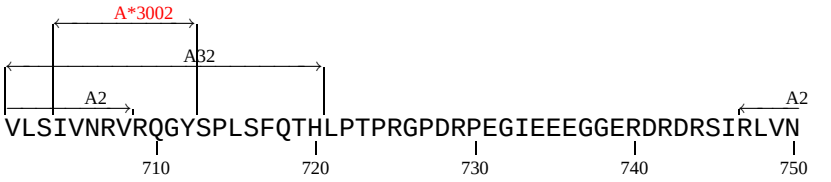


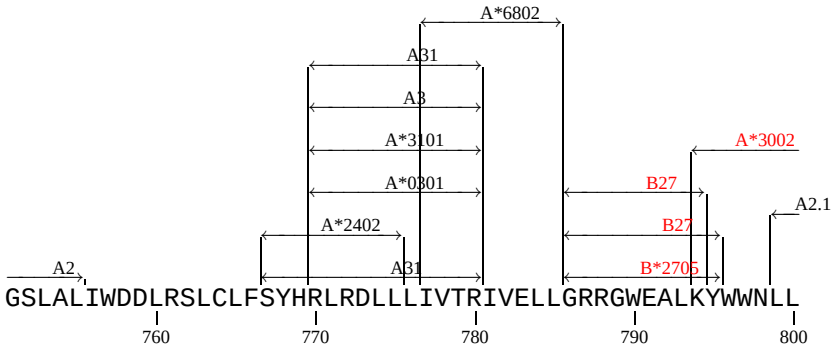


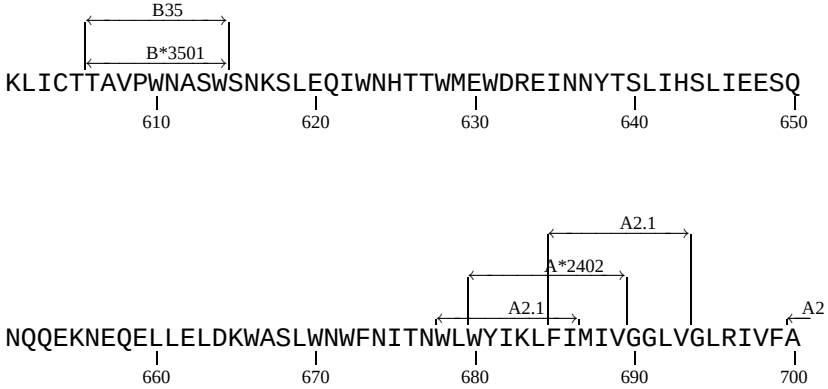


gp120 end <> gp41 start

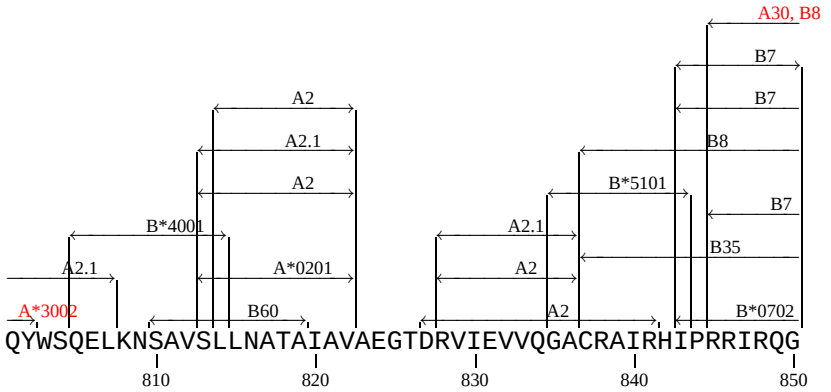

B8
B*0801
A*2402
Cw7
B27
A*2402
A*2402
A*2402
B14, B*1402
B14
B*1402
B14
B51
B15
B*5101
DPw4.2
CD4+ CTL(DR-1)
QQNNLLRAIEAQQHLLQLTVWGIKQLQARILAVERYLKDQQLLGIWGCSG
560
570
580
590
600

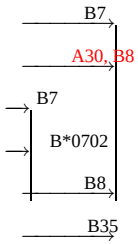

A*3002
A32
A2
A2
VLSIVNRVRQGYSPLSFQTHLPTPRGPDRPEGIEEEGGERDRDRSIRLVN
710
720
730
740
750


A*6802
A31
A3
A*3101
A*0301
A*2402
A2
A31
A*3002
B27
B27
B*2705
A2.1
GSLALIWDDLRSLCLFSYHRLRDLLLIVTRIVELLGRRGWEALKYWWNLL
760
770
780
790
800


B35
B*3501
KLICTTAVPWNASWSNKSLEQIWNHTTWMEWDREINNYTSLIHSLIEESQ
610
620
630
640
650

A2.1
A*2402
A2.1
A2
NQQEKNEQELLELDKWASLWNWFNITNWLWYIKLFIMIVGGLVGLRIVFA
660
670
680
690
700

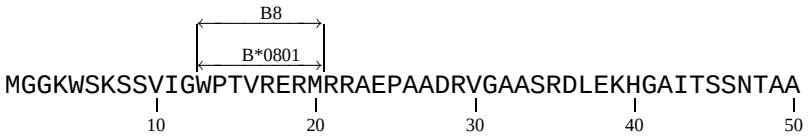

A30, B8
B7
B7
A2
A2.1
B8
A2
B*5101
B*4001
B7
A2.1
A2.1
B35
A*0201
A2
A*3002
B60
A2
B*0702
QYWSQELKNSAVSLLNATAIAVAEGTDRVIEVVQGACRAIRHIPRRIRQG
810
820
830
840
850

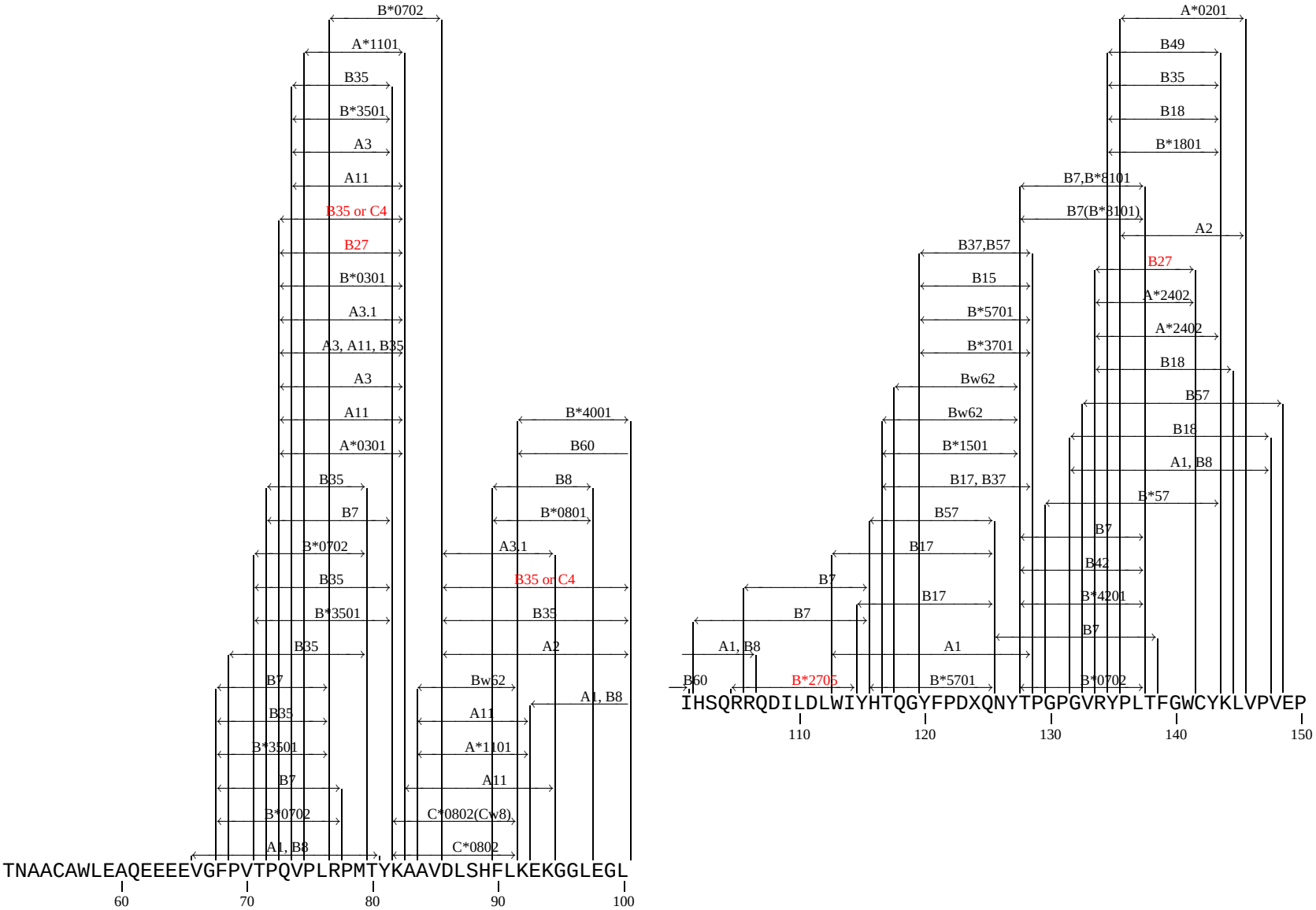


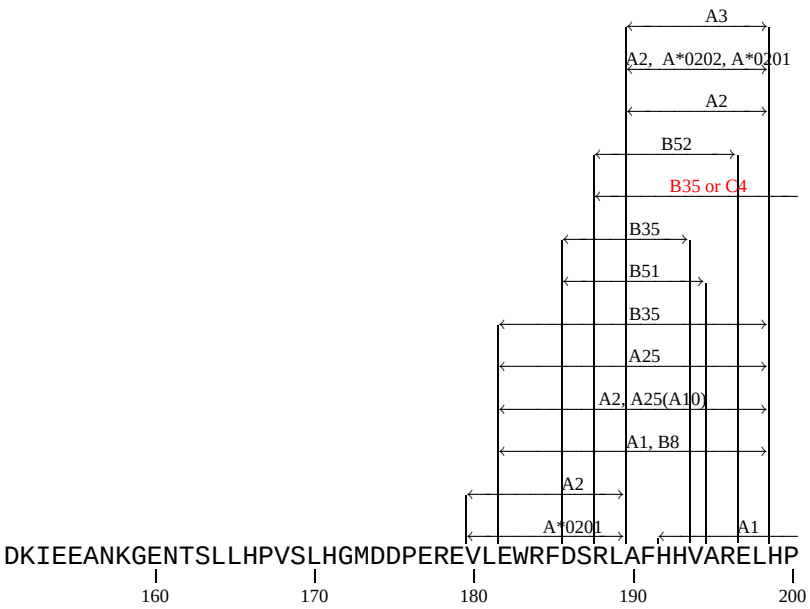
LERILL

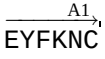
-> gp41 end

Nef CTL Map




B*0702
A*1101
B35
B*3501
A3
A11
B35 or C4
B27
B*0301
A3.1
A3, A11, B35
A3
A11
A*0301
B35
B7
B*0702
B35
B*3501
B35
B7
B35
B*3501
B7
B*0702
A1, B8
B*4001
B60
B8
B*0801
A3.1
B35 or C4
B35
A2
Bw62
A1, B8
A11
A*1101
A11
C*0802(Cw8)
C*0802
TNAACAWLEAQEEEEVGFPVTPQVPLRPMTYKAAVDLSHFLKEKGGLEGL
60
70
80
90
100
A*0201
B49
B35
B18
B*1801
B7,B*8101
B7(B*3101)
A2
B37,B57
B27
B15
A*2402
B*5701
A*2402
B*3701
B18
Bw62
B57
Bw62
B18
B*1501
A1, B8
B17, B37
B*57
B57
B7
B17
B42
B7
B17
B*4201
B7
B7
A1, B8
A1
B60
B*2705
B*5701
B*0702
IHSQRRQDILDLWIYHTQGYFPDXQNYTPGPGVRYPLTFGWCYKLVPVEP
110
120
130
140
150





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to allogeneic CTL clones of each of the other haplotypes, whereas none of these cross- presents to H-2q CTL, nor do H-2q targets present to CTL of the other haplotypes. Here, we explore the critical amino acid residues for the cross-presentation using 10 variant peptides with single amino acid substitutions. The £ne speci£city examined using these mutant peptides presented by the same MHC class I molecule showed striking similarity among the CTL of each haplotype, expressing either V beta 8.1 or V beta 14. In contrast, the £ne speci£city is different between the distinct MHC class I molecules even for the lysis by the same CTL, as shown by reciprocal effects of the same substitutions. Thus, peptide £ne speci£city of a single TCR is in¤uenced by changes in the class I MHC molecules presenting the Ag.

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and eliminate virally infected cells before new virions are produced within that cell. Therefore, a rapid and vigorous CD8+ CTL response, induced by vaccination, can, in principle, prevent disseminated infection in vaccinated individuals who are exposed to the relevant virus. There has thus been interest in novel vaccine strategies that will enhance the induction of CD8+ CTLs. In this study, we have tested the hypothesis that targeting an antigen to undergo more ef£cient processing by the class I processing pathway will elicit a more vigorous CD8+ CTL response against that antigen. Targeting a type I transmembrane protein, the HIV-1 envelope (env) protein, for expression in the cytoplasm, rather than allowing its normal co-translational translocation into the endoplasmic reticulum, sensitized target cells expressing this mutant more rapidly for lysis by an env-speci£c CTL clone. Additionally, a greatly enhanced de novo env-specifc CTL response was induced *in vivo* after immunization of mice with recombinant vaccinia vectors expressing the cytoplasmic env mutant. Similarly, targeting a cytoplasmic protein, HIV-1 nef, to undergo rapid cytoplasmic degradation induced a greatly enhanced de novo nef-speci£c CD8+ CTL response *in vivo* after immunization of mice with either recombinant vaccinia vectors or DNA expression plasmids expressing the degradation targeted nef mutant. The targeting of viral antigens for rapid cytoplasmic degradation represents a novel and highly effective vaccine strategy for the induction of enhanced de novo CTL responses *in vivo*.

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